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(54) **METHOD AND APPARATUS FOR TENSIONING A SUTURE**

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(58) **Field of Classification Search**

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See application file for complete search history.

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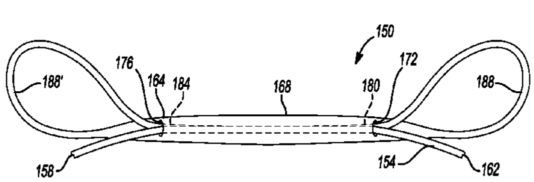
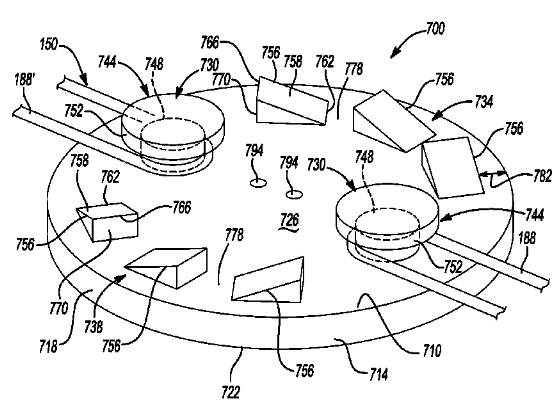
(57) **ABSTRACT**

An apparatus can include a tensioning member having a body defining a first bone engaging surface, a second opposite suture receiving surface, and an outer perimeter. First and second suture attachment members can be positioned relative to the second surface and spaced apart from each other, and can be configured to be coupled to a suture. First and second suture engaging members can extend from the second surface and can be positioned in spaced relation to the first and second suture attachment members. Rotation of the tensioning member in a first direction can selectively engage the first and second suture receiving members with the suture, thereby forming a non-linear path of travel of the suture relative to the first and second suture attachment members and suture engaging members and increasing the tension in the suture.

31 Claims, 28 Drawing Sheets





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8,562,647, which is a continuation-in-part of application No. 12/719,337, filed on Mar. 8, 2010, now Pat. No. 9,078,644, which is a continuation-in-part of application No. 12/489,168, filed on Jun. 22, 2009, now Pat. No. 8,361,113, which is a continuation-in-part of application No. 12/474,802, filed on May 29, 2009, now Pat. No. 8,088,130, which is a continuation-in-part of application No. 12/196,405, filed on Aug. 22, 2008, now Pat. No. 8,128,658, and a continuation-in-part of application No. 12/196,407, filed on Aug. 22, 2008, now Pat. No. 8,137,382, and a continuation-in-part of application No. 12/196,410, filed on Aug. 22, 2008, now Pat. No. 8,118,836, and a continuation-in-part of application No. 11/541,506, filed on Sep. 29, 2006, now Pat. No. 7,601,165, application No. 13/295,126, which is a continuation-in-part of application No. 12/570,854, filed on Sep. 30, 2009, now Pat. No. 8,303,604, which is a continuation-in-part of application No. 12/014,399, filed on Jan. 15, 2008, now Pat. No. 7,909,851, which is a continuation-in-part of application No. 11/347,661, filed on Feb. 3, 2006, now Pat. No. 7,749,250, application No. 13/295,126, which is a continuation-in-part of application No. 12/029,861, filed on Feb. 12, 2008, now Pat. No. 8,251,998, which is a continuation-in-part of application No. 11/504,882, filed on Aug. 16, 2006, now Pat. No. 8,998,949, which is a continuation-in-part of application No. 11/408,282, filed on Apr. 20, 2006, now abandoned, application No. 13/295,126, which is a continuation-in-part of application No. 12/702,067, filed on Feb. 8, 2010, now Pat. No. 8,672,968, which is a continuation of application No. 11/541,505, filed on Sep. 29, 2006, now Pat. No. 7,658,751, application No. 13/295,126, which is a continuation-in-part of application No. 13/102,182, filed on May 6, 2011, now Pat. No. 8,231,654, which is a division of application No. 12/196,398, filed on Aug. 22, 2008, now Pat. No. 7,959,650, which is a continuation-in-part of application No. 11/784,821, filed on Apr. 10, 2007, now Pat. No. 9,017,381.

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A61B 17/00	(2006.01)
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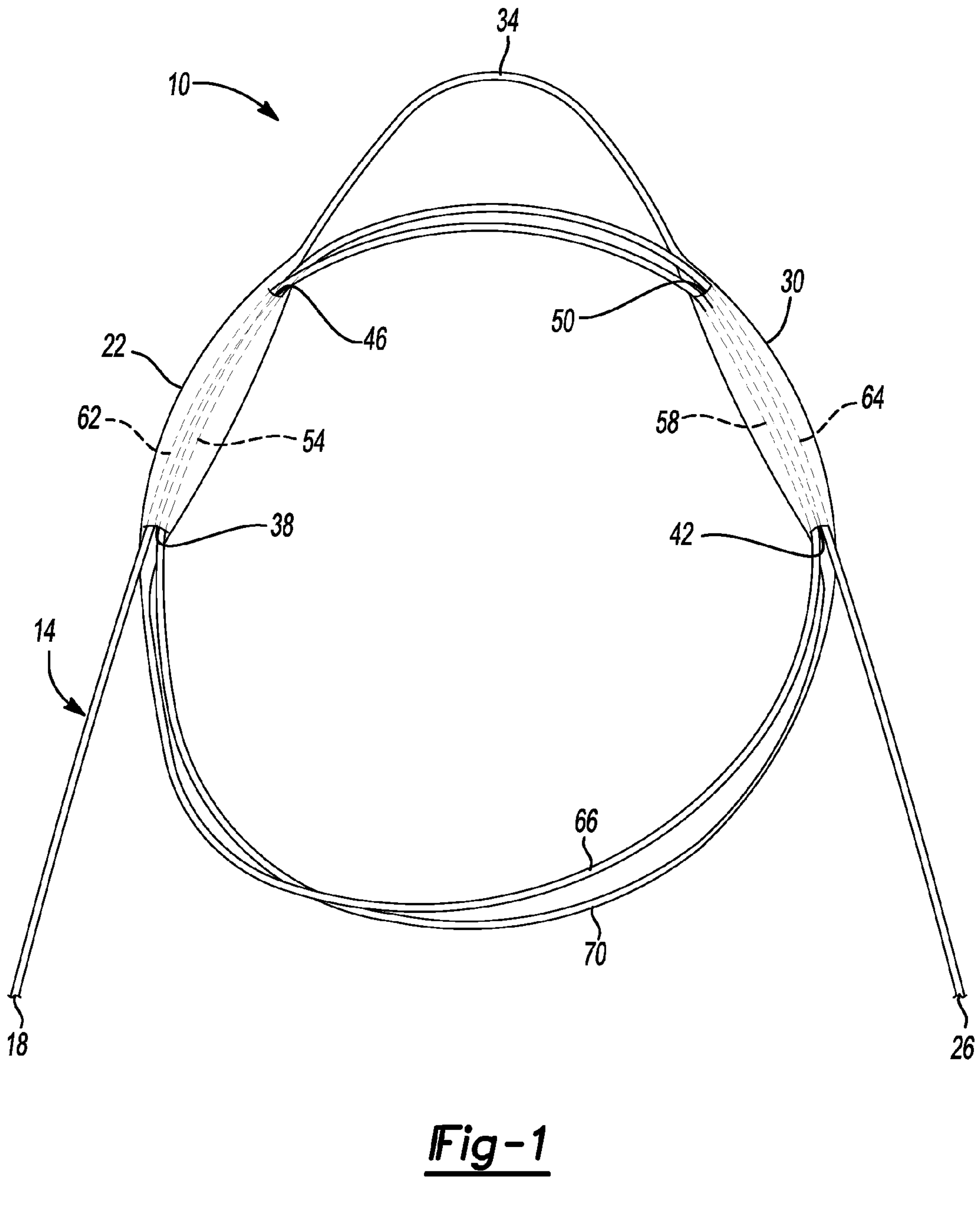

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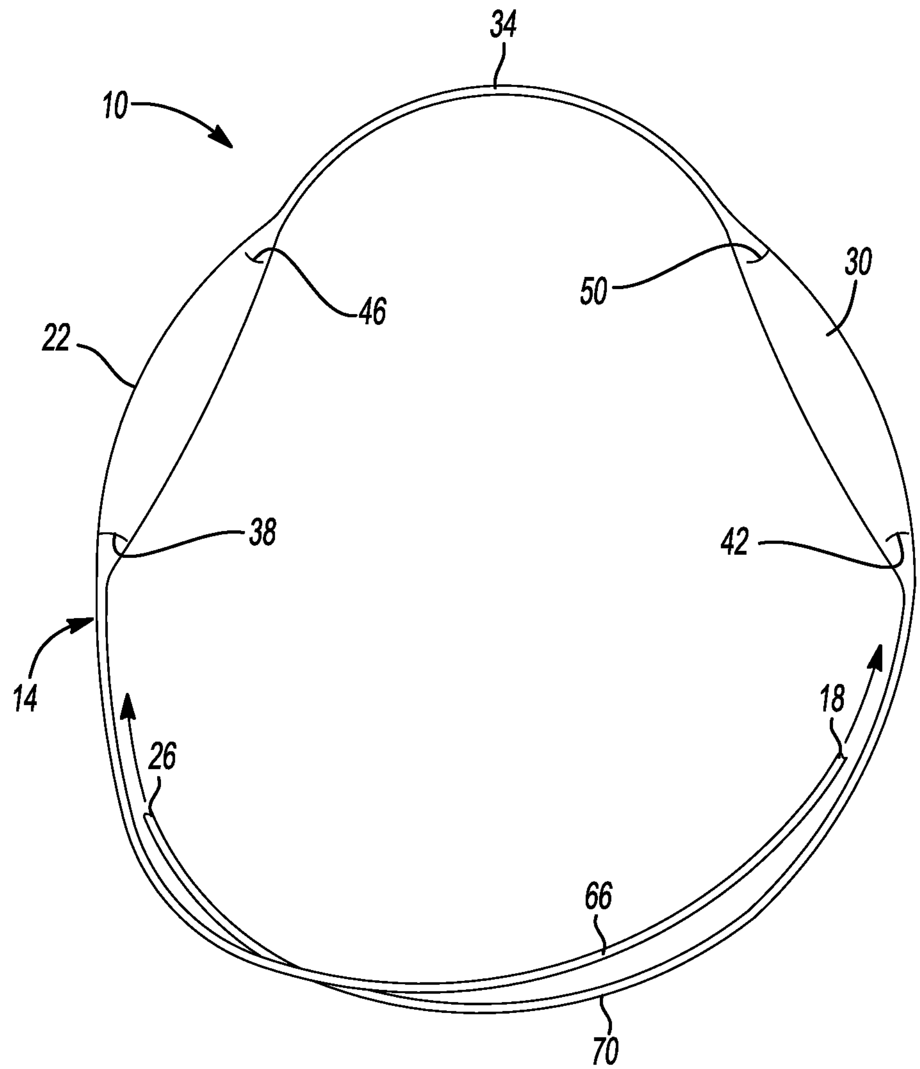

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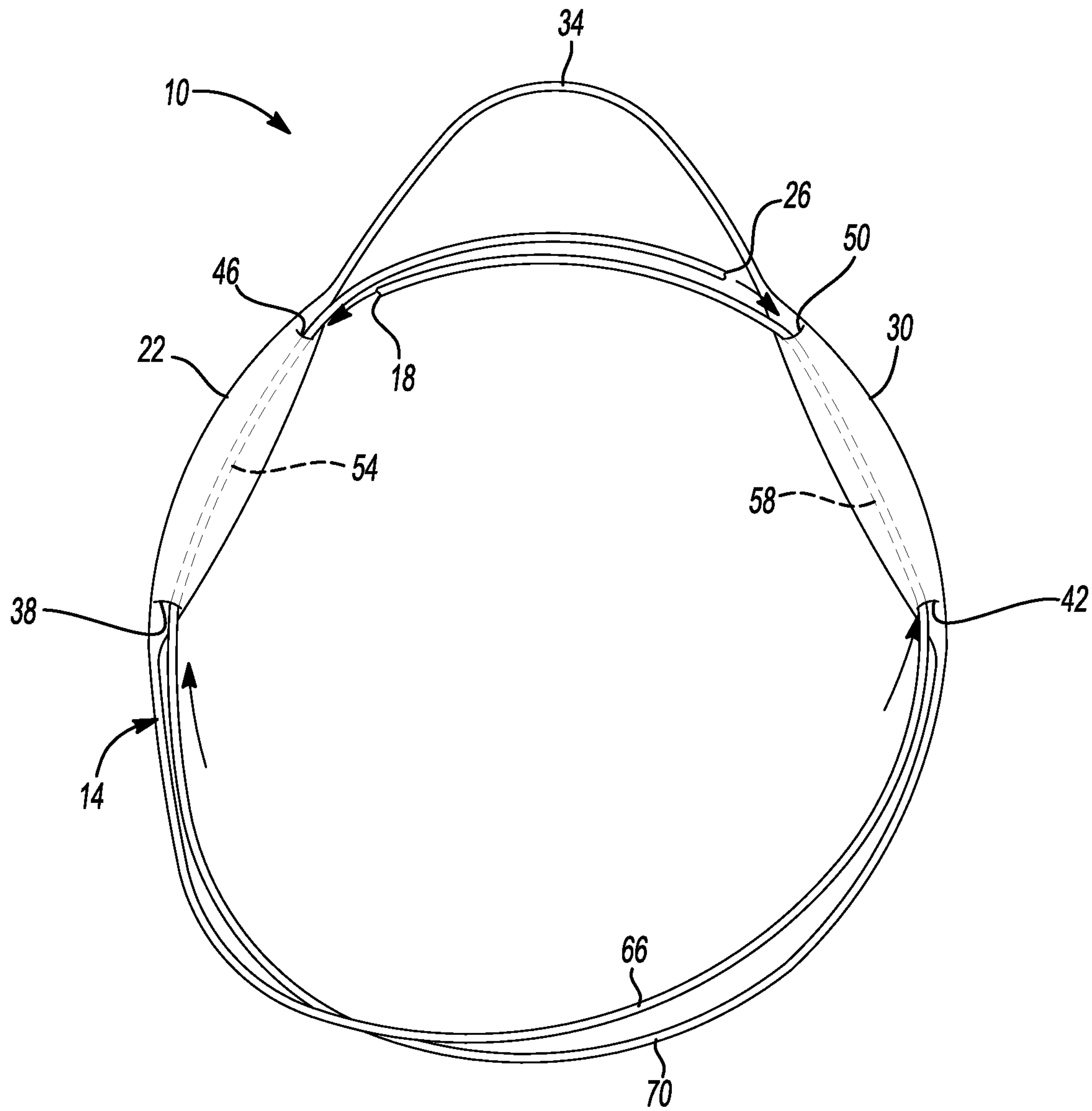

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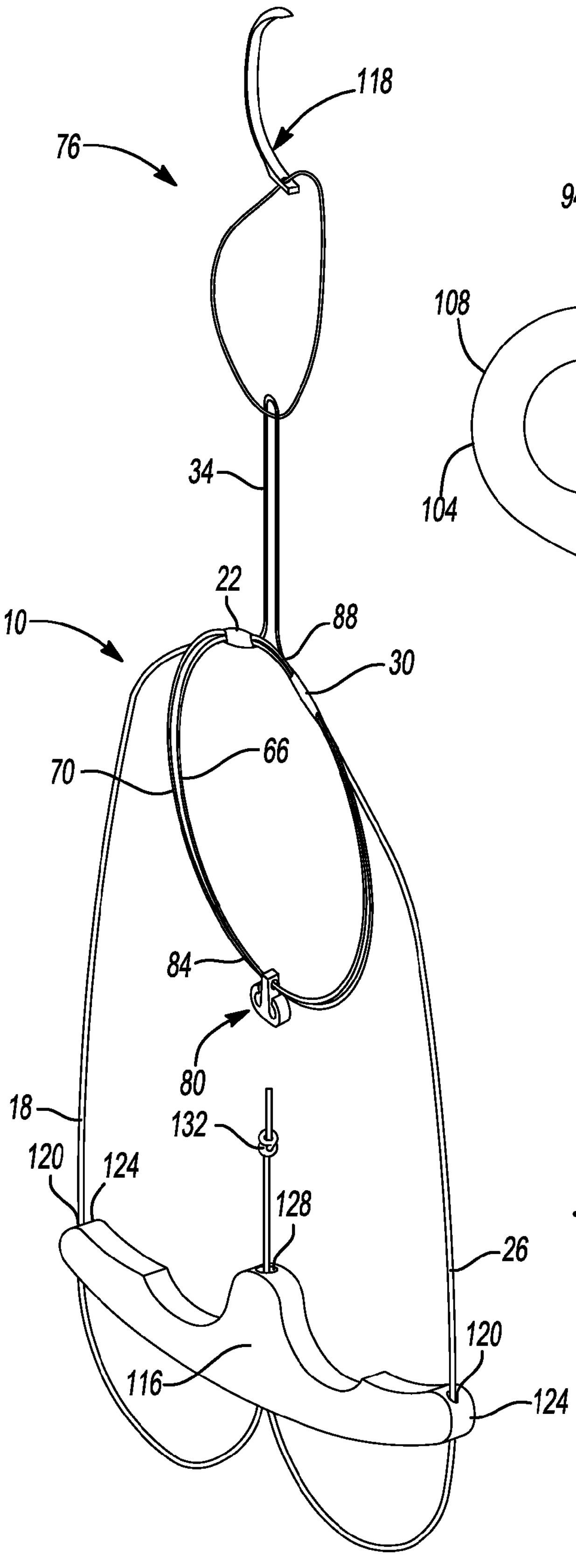
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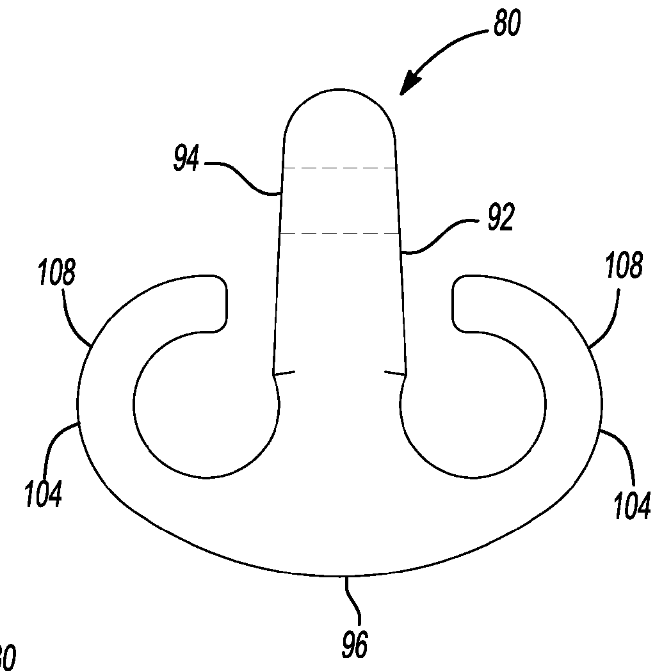
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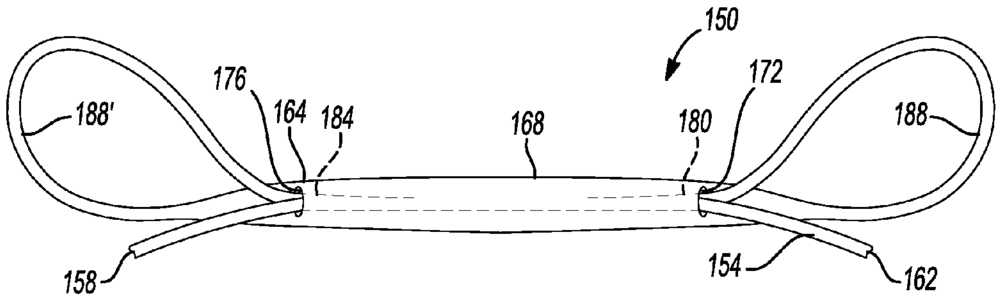

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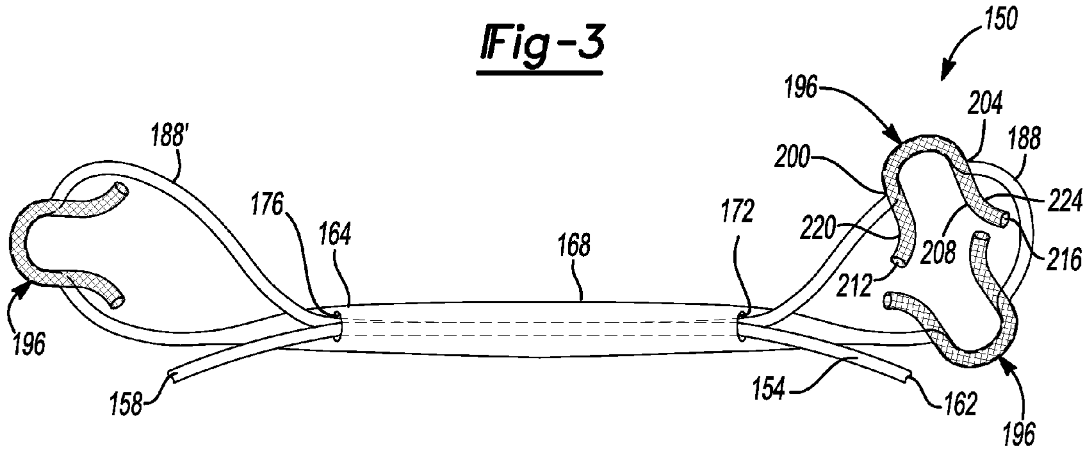

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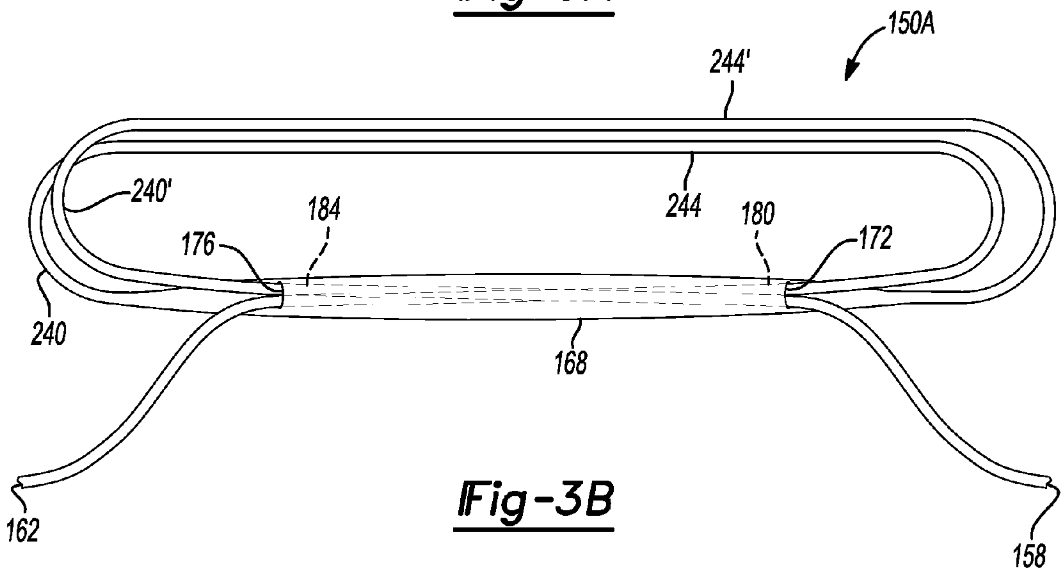

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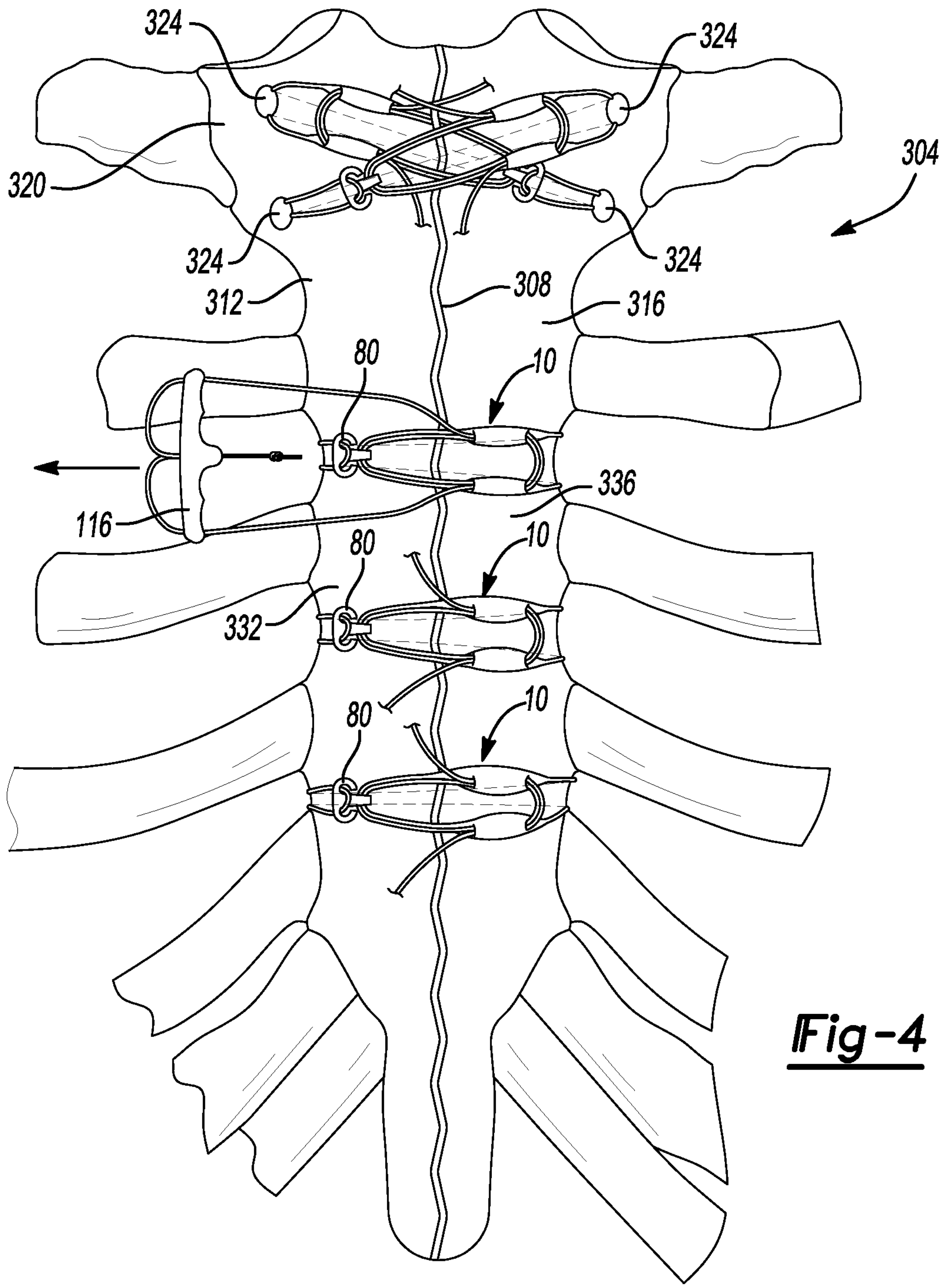

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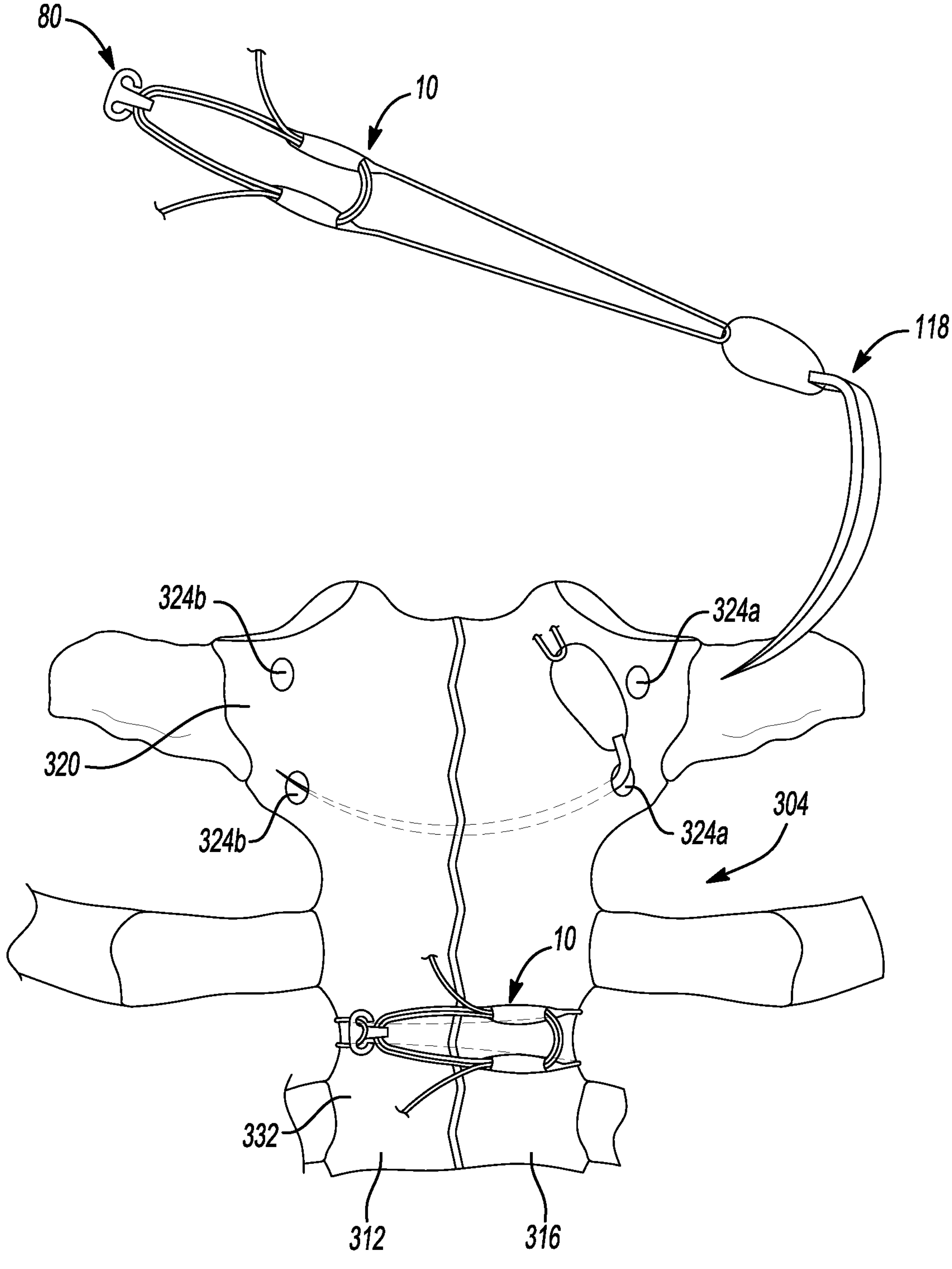

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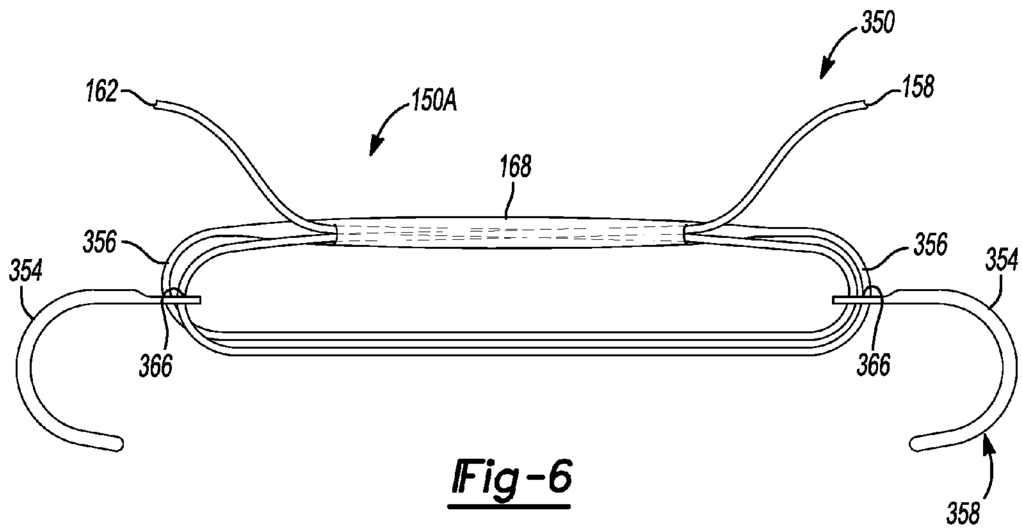
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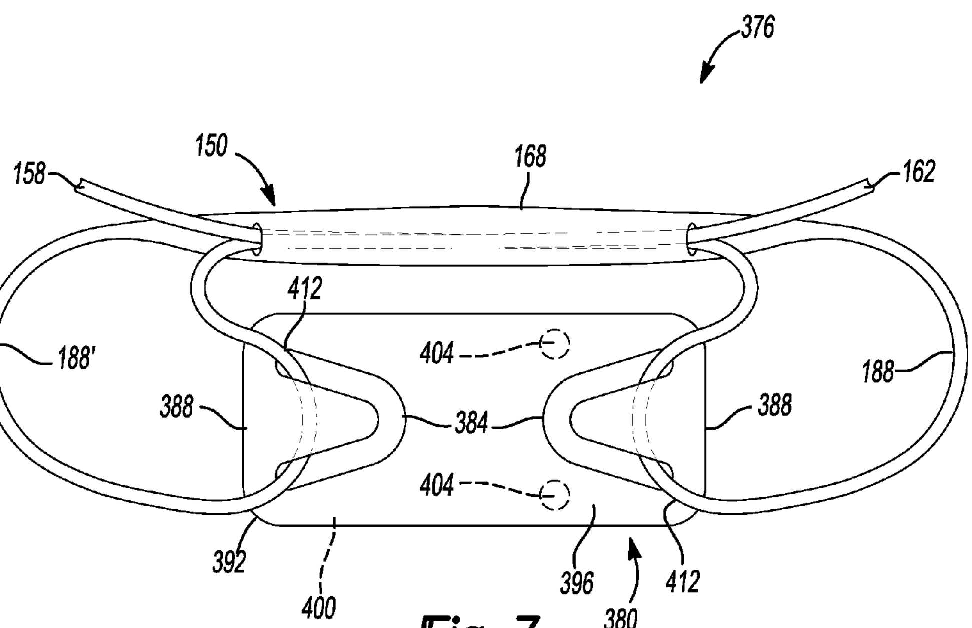
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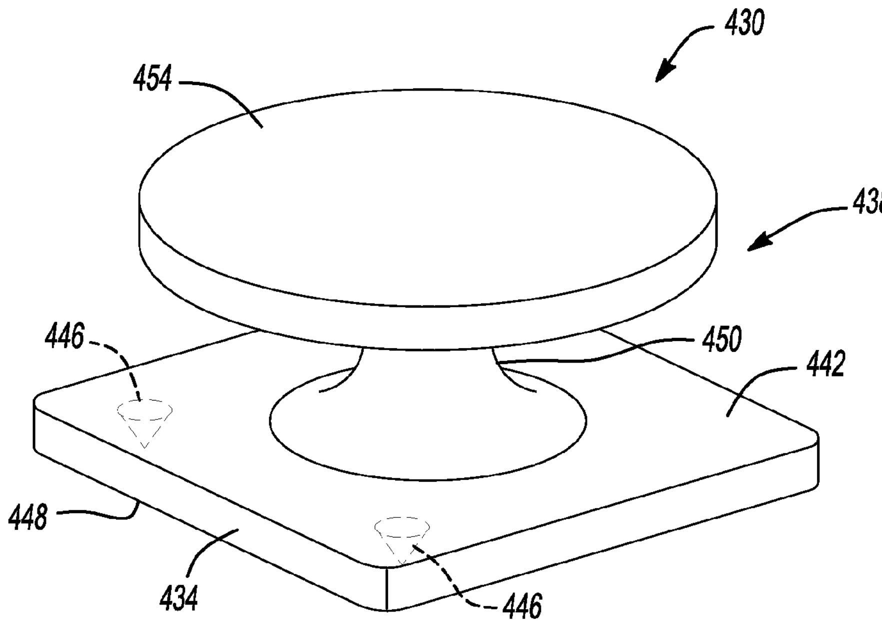
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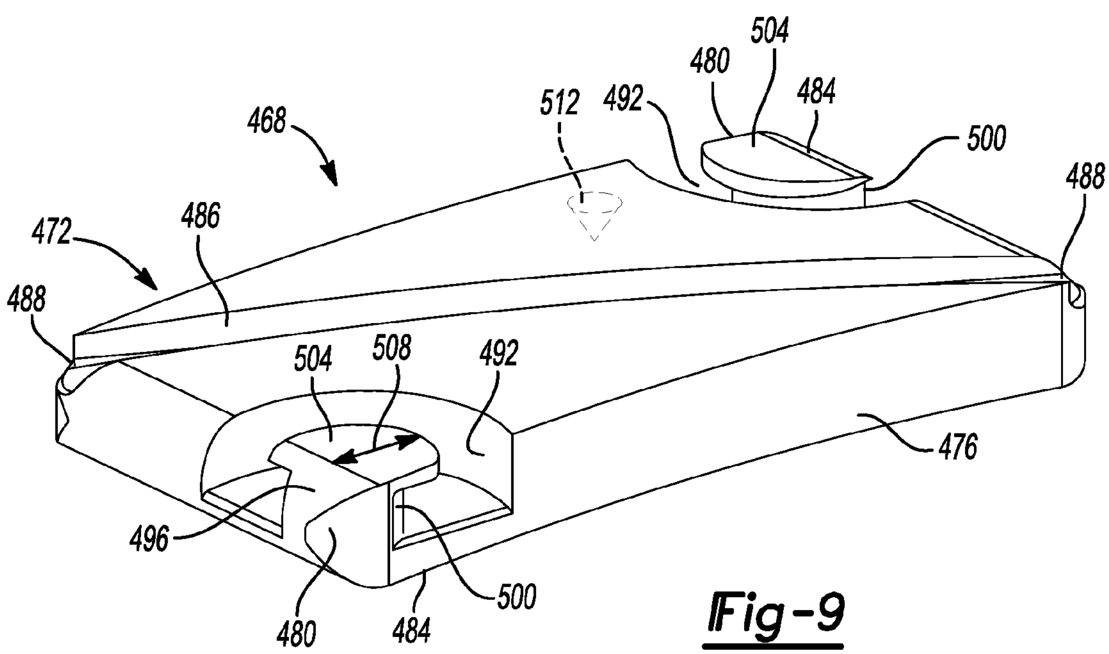
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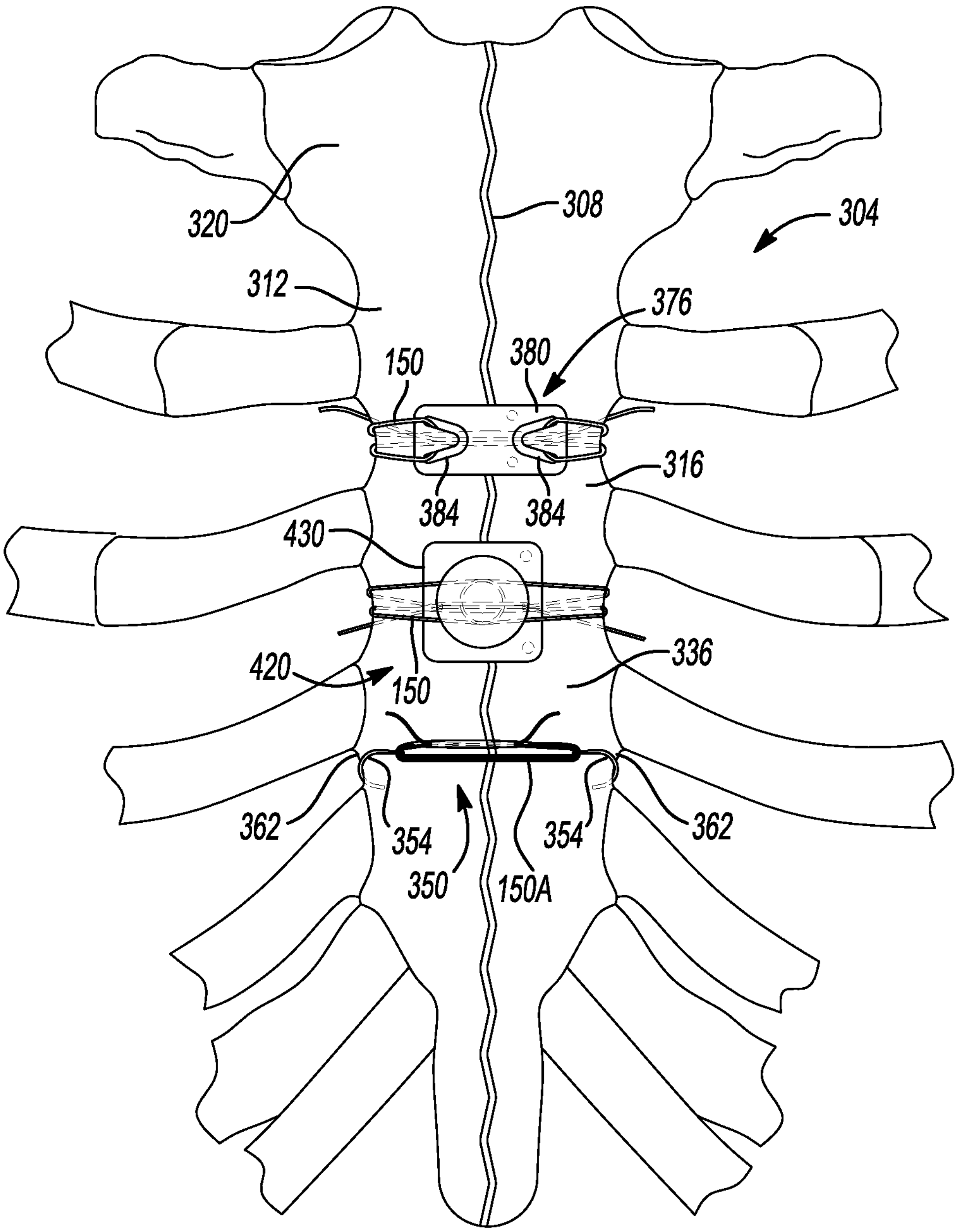
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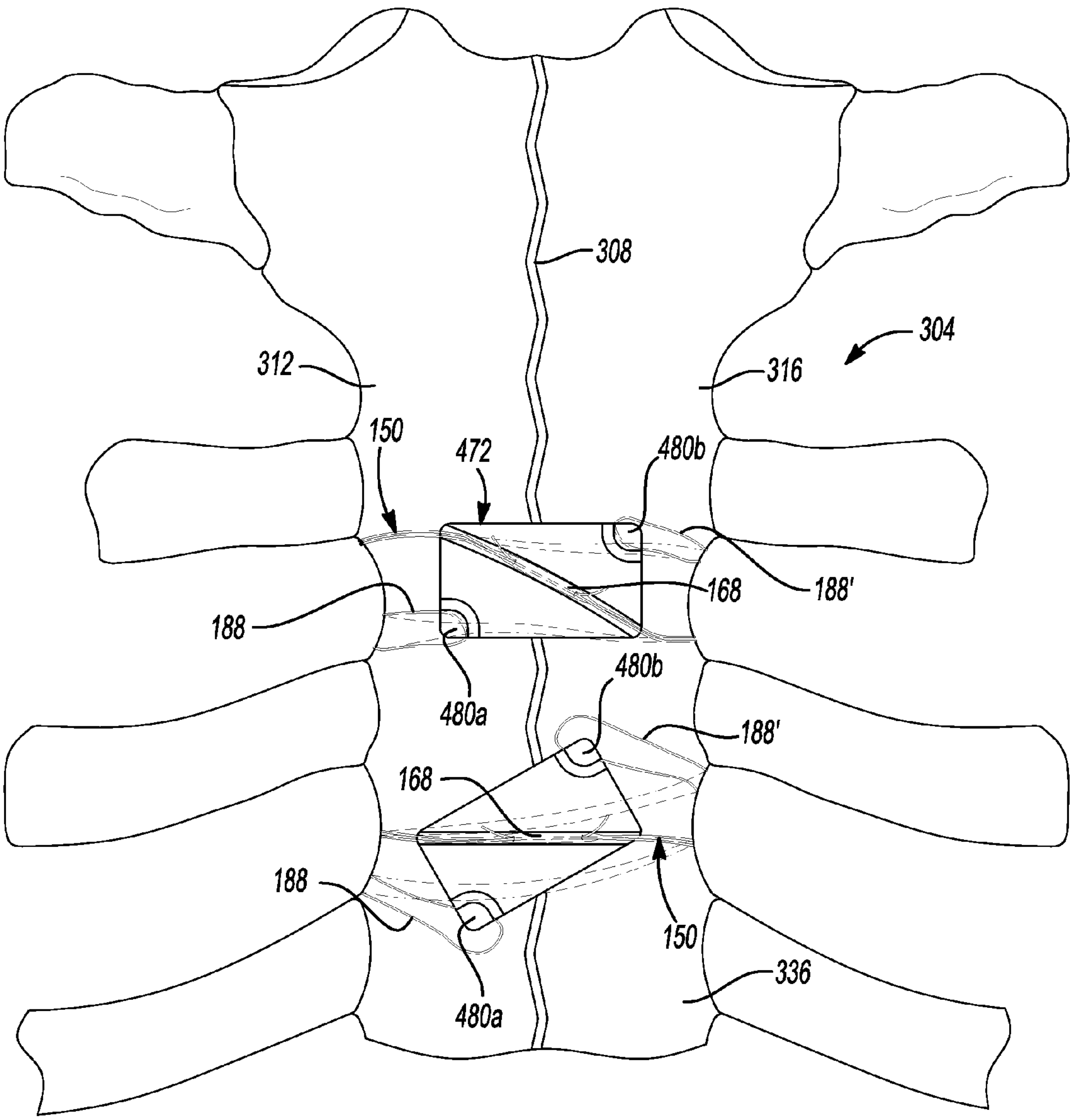
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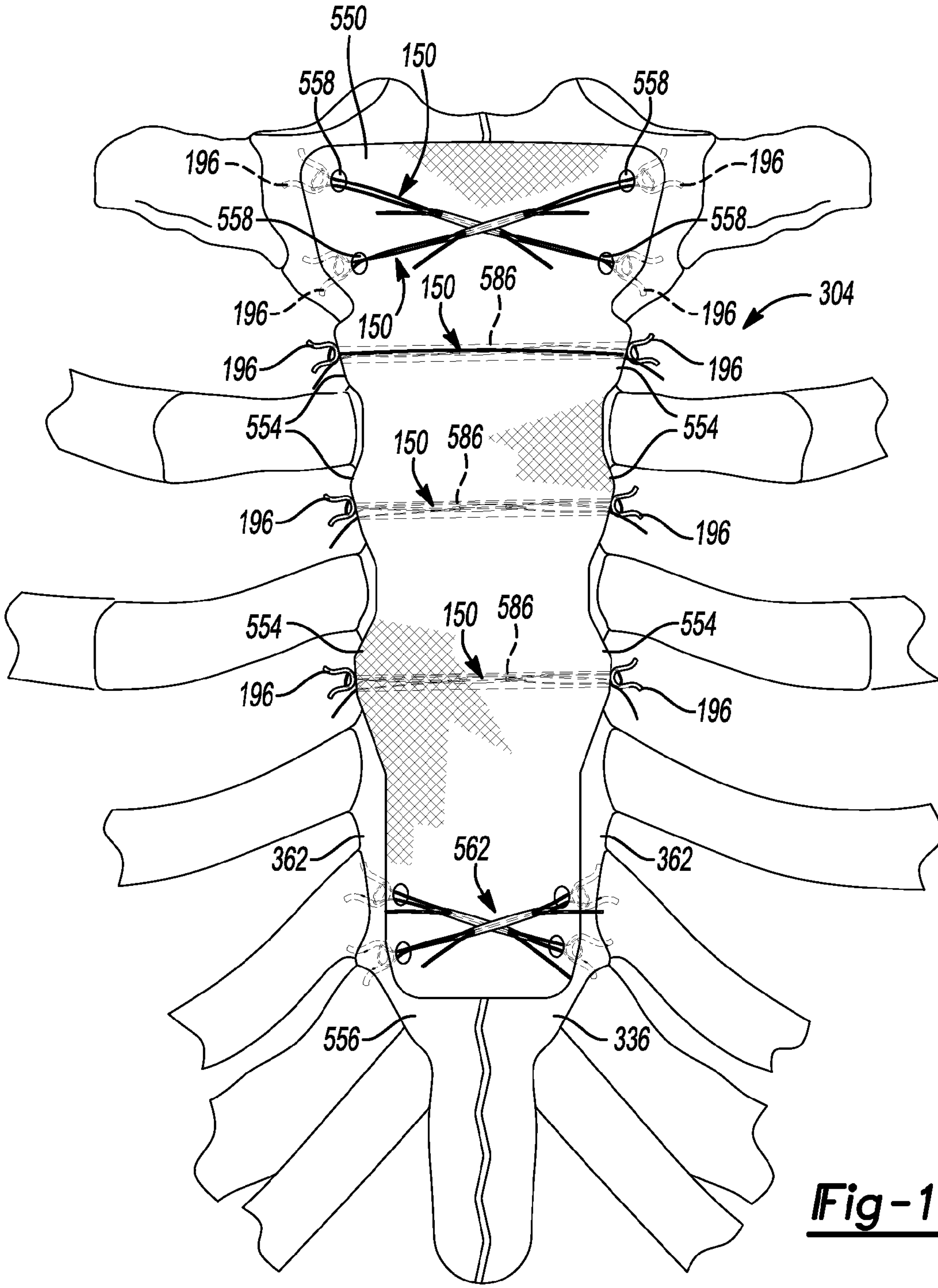
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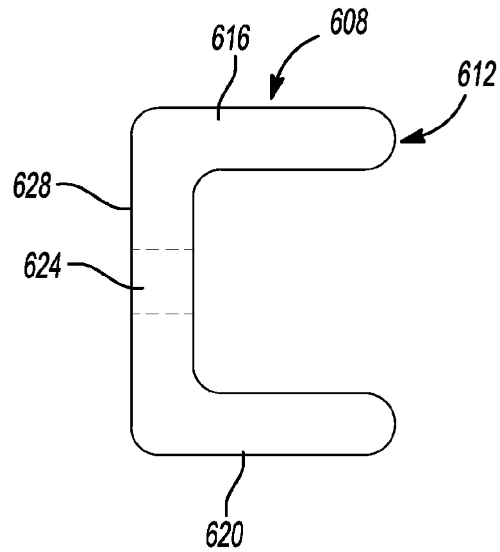
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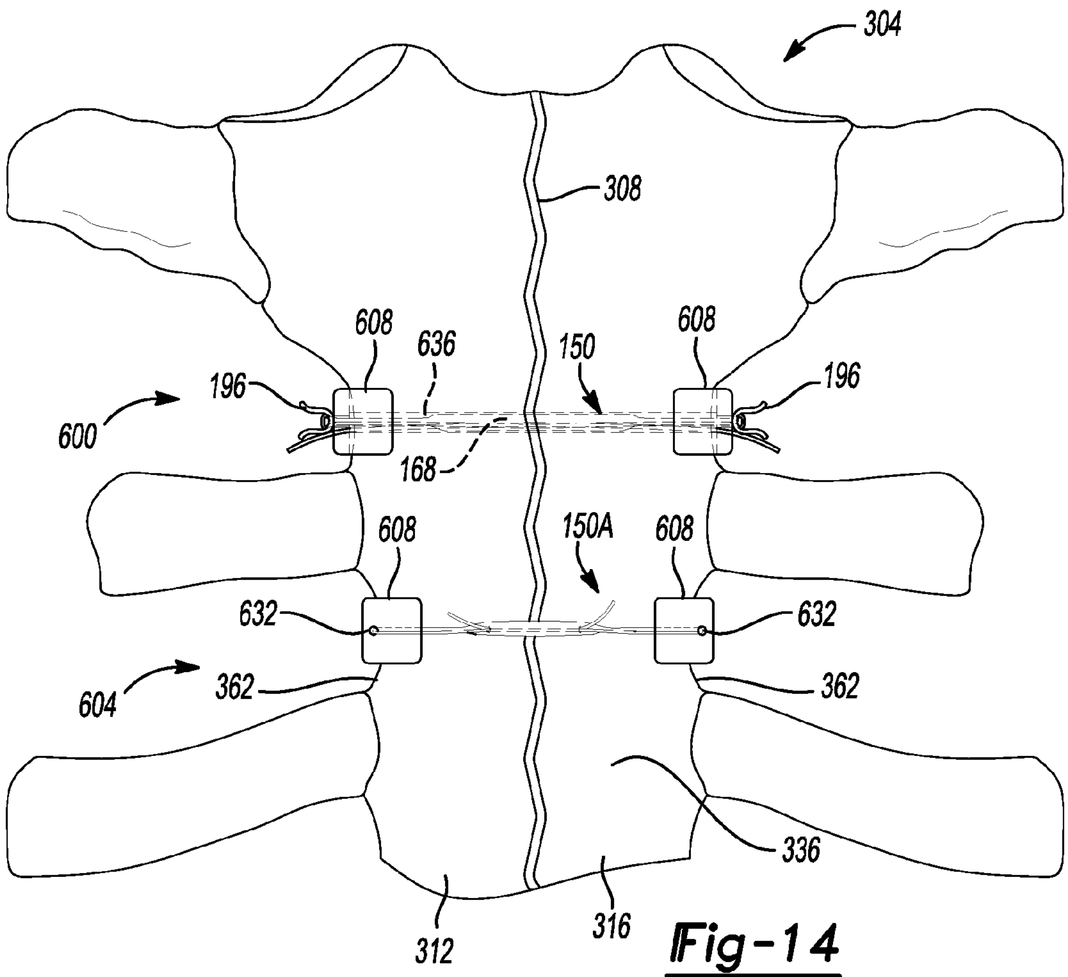
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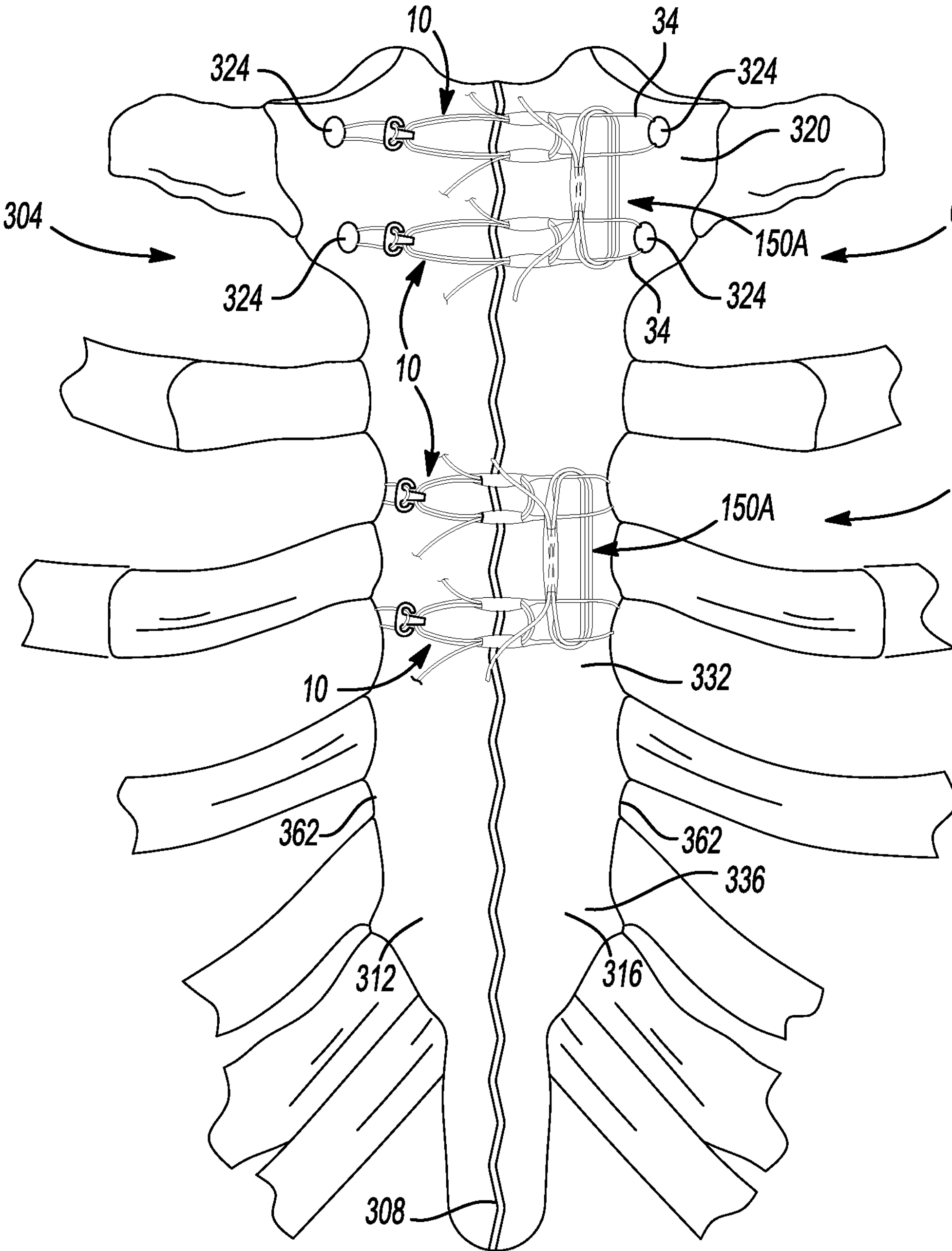
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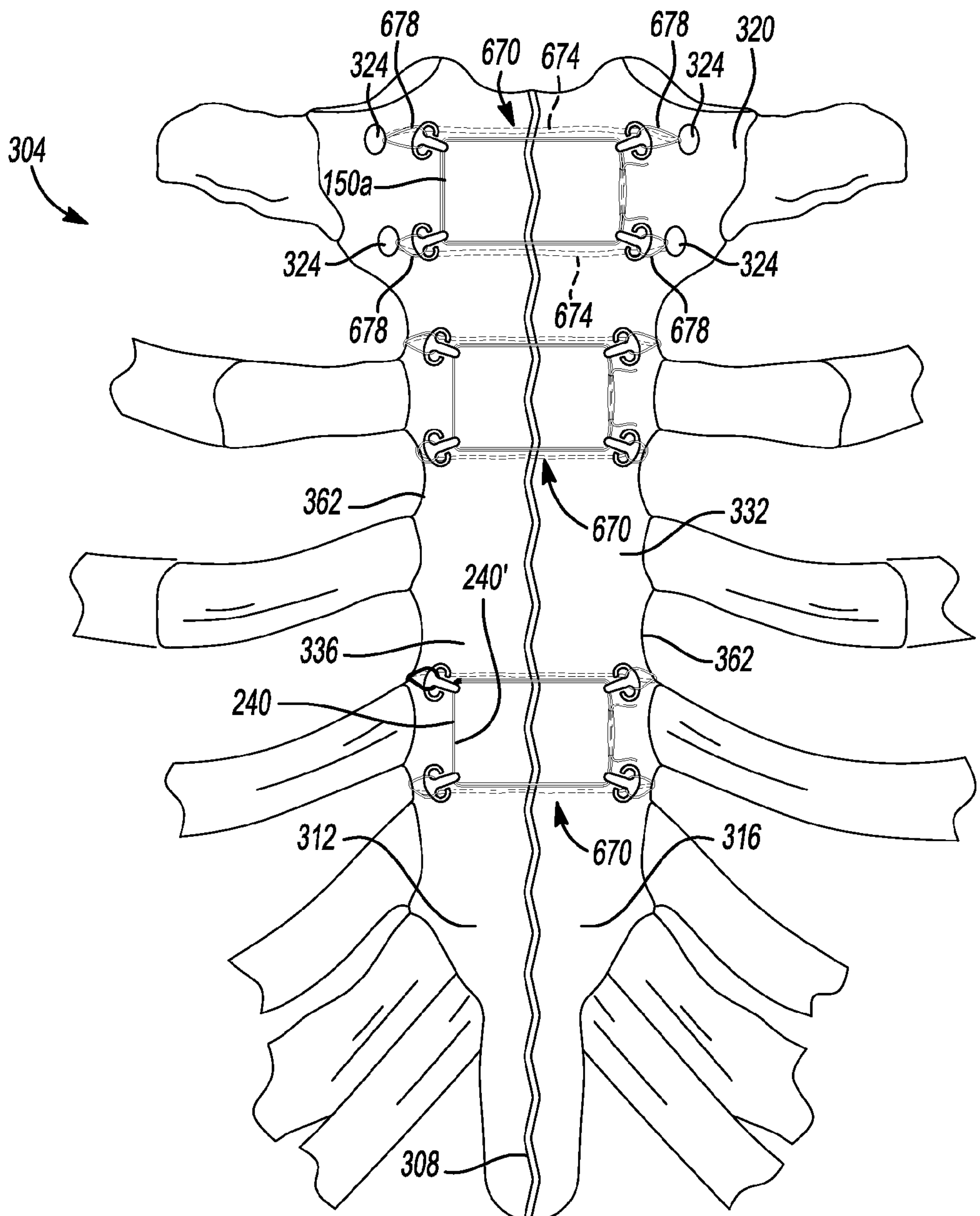

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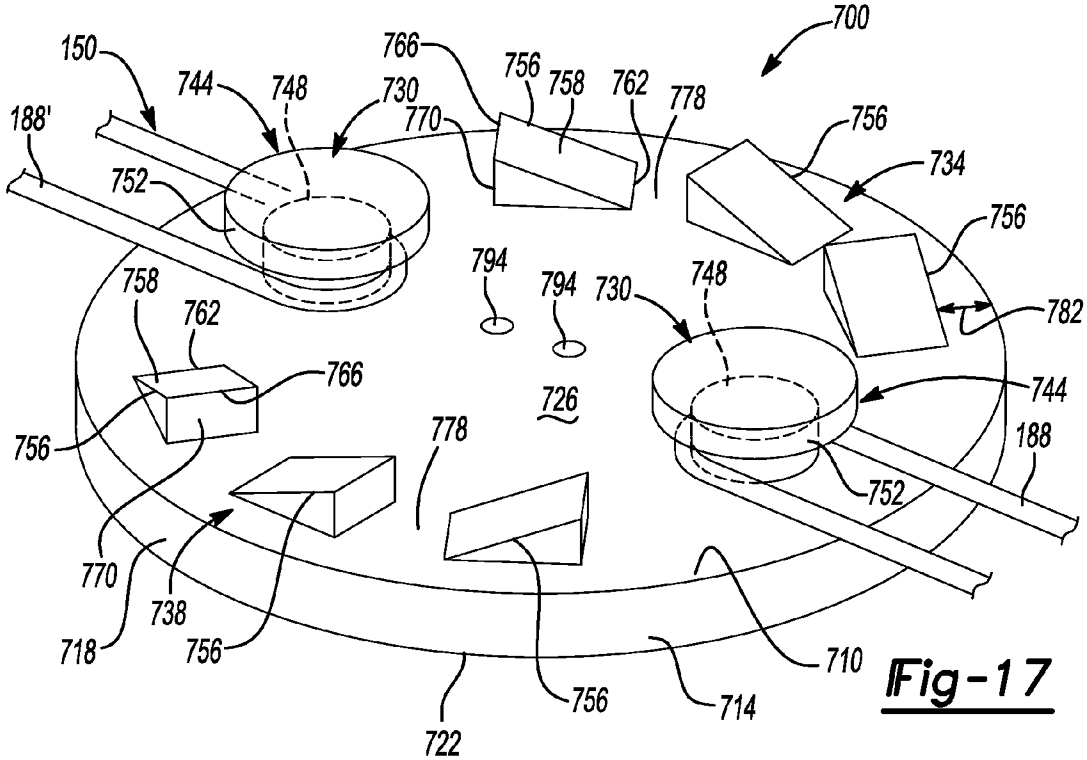
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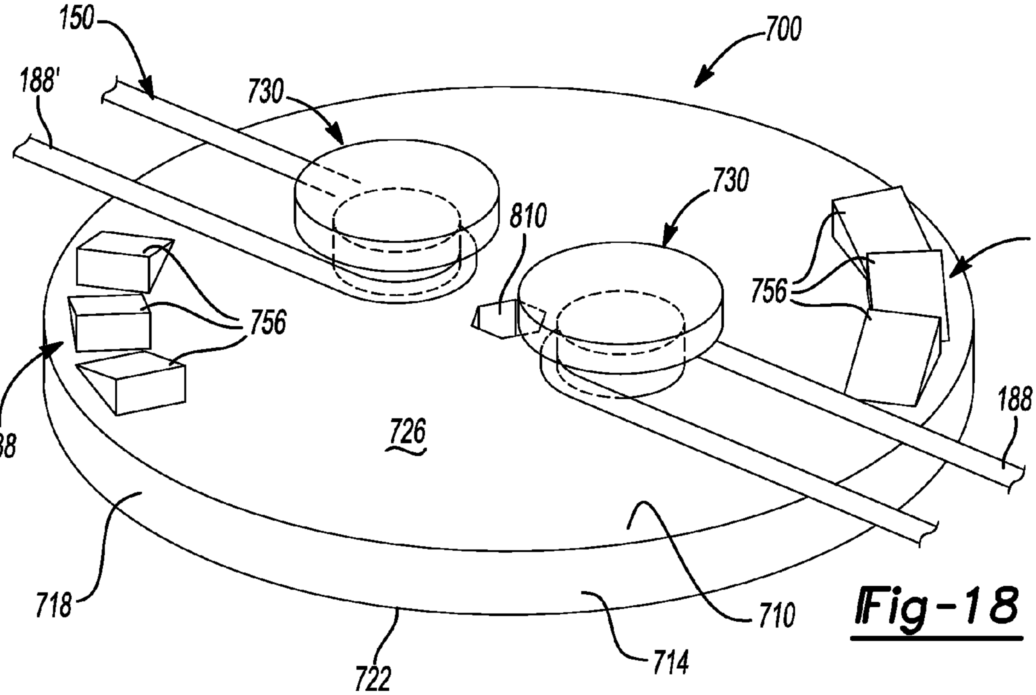
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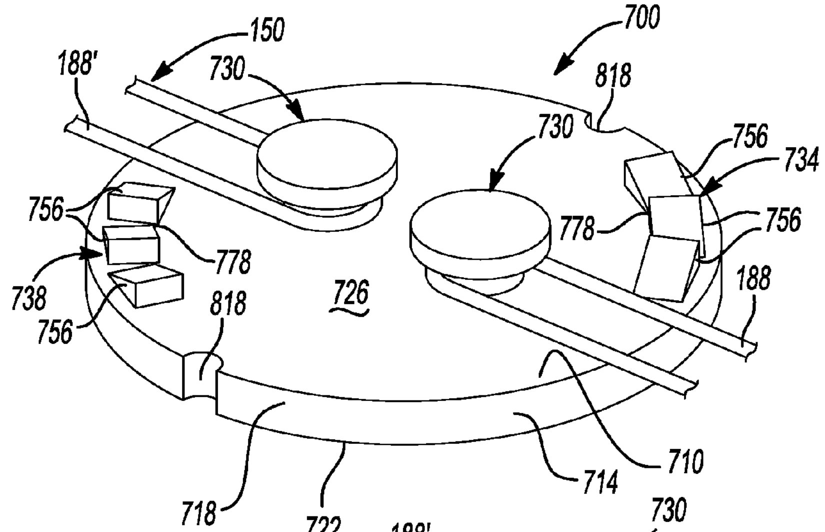

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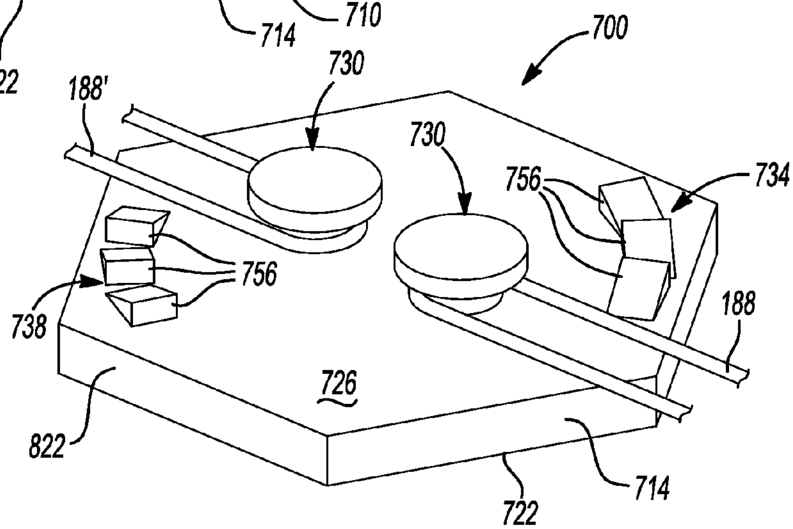


Fig-20

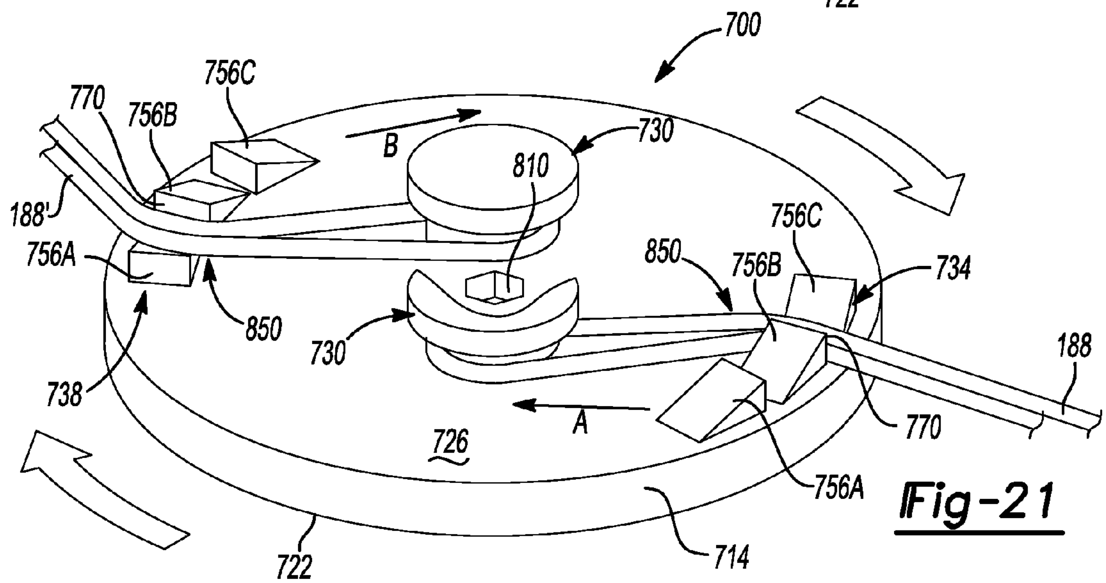
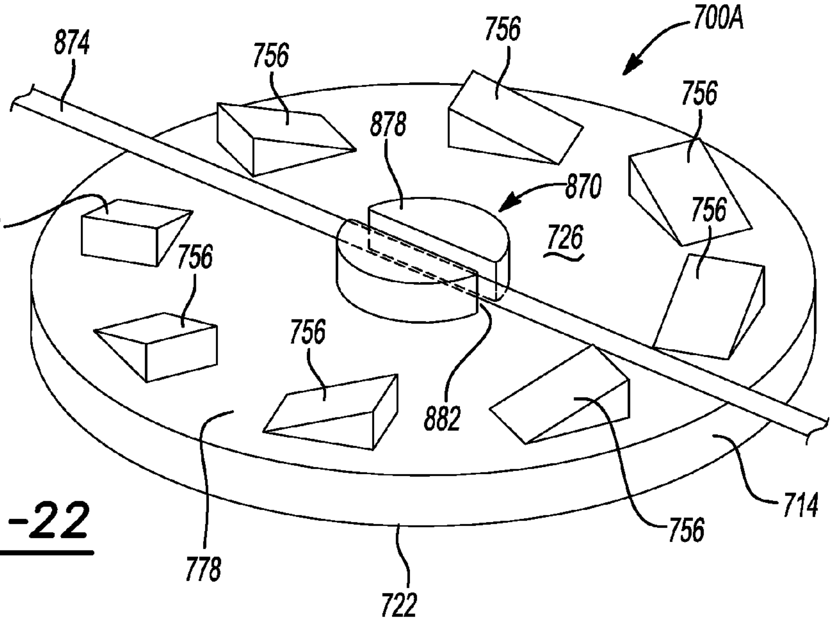


Fig-21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700A
756
878
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726
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756
882
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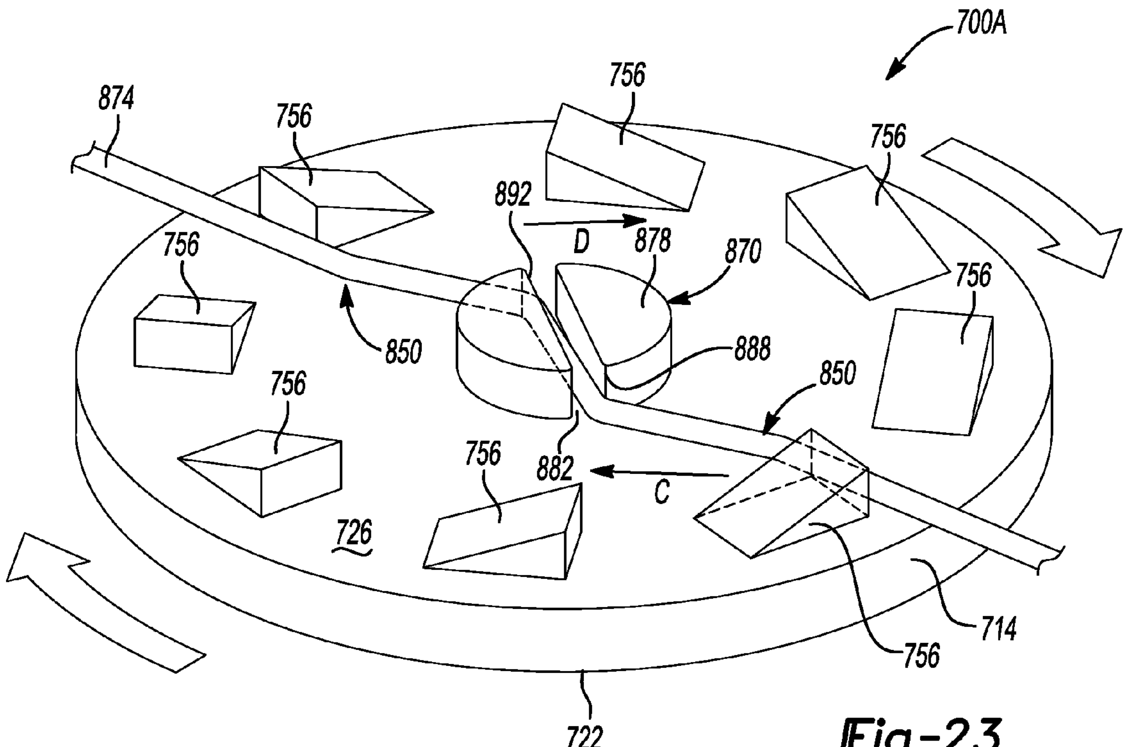
714
778
722

Fig-22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874
756
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D
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870
756
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888
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756
882
C
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726
756
714
722

Fig-23

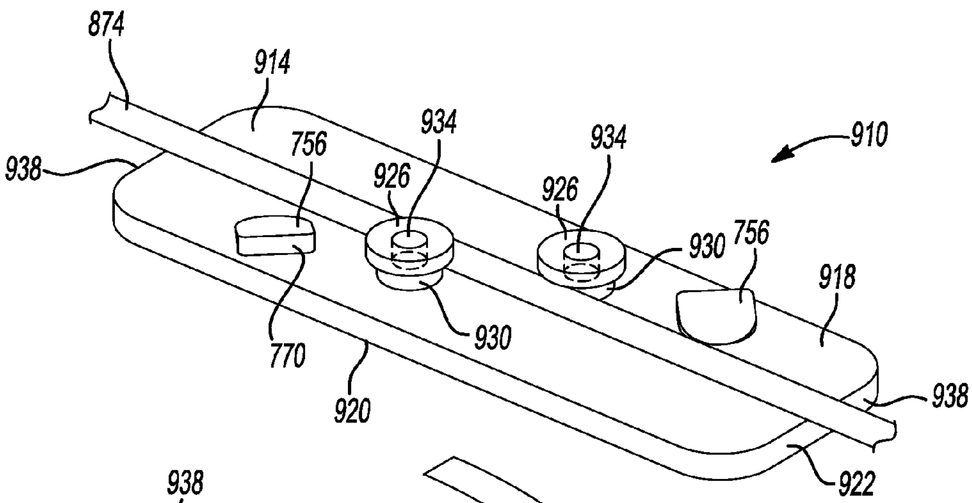


Fig-24

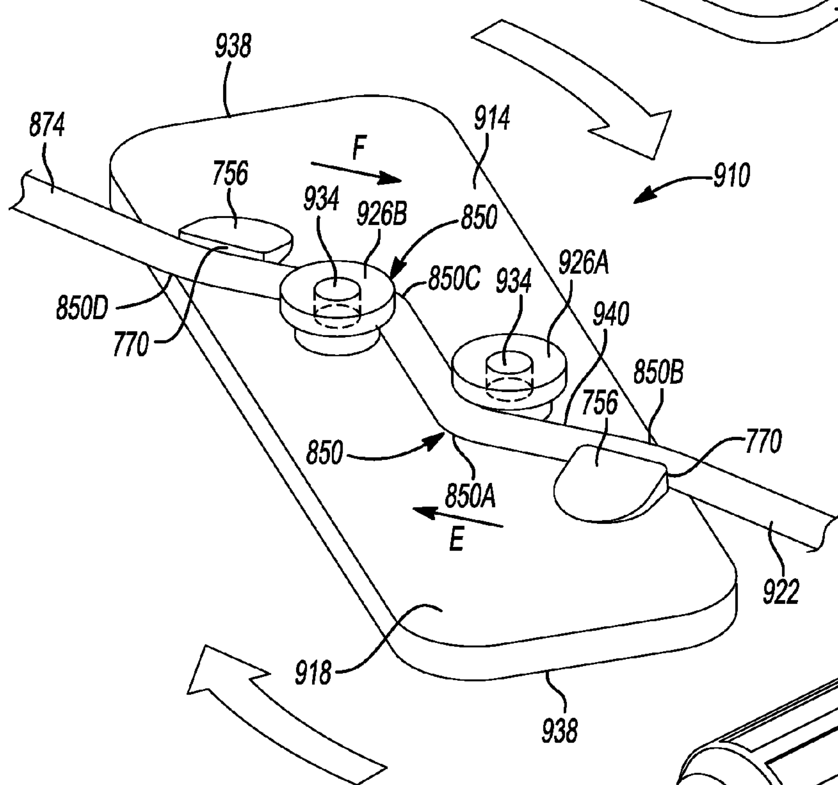


Fig-25

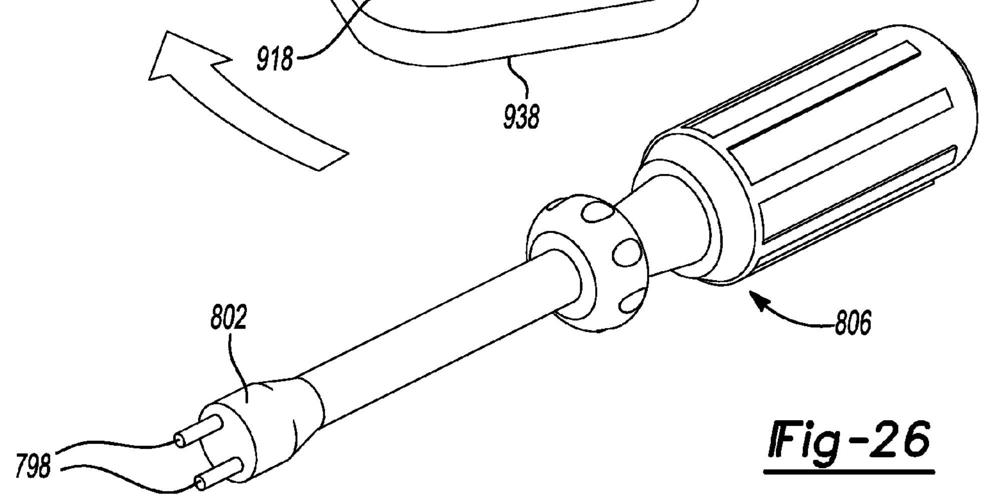
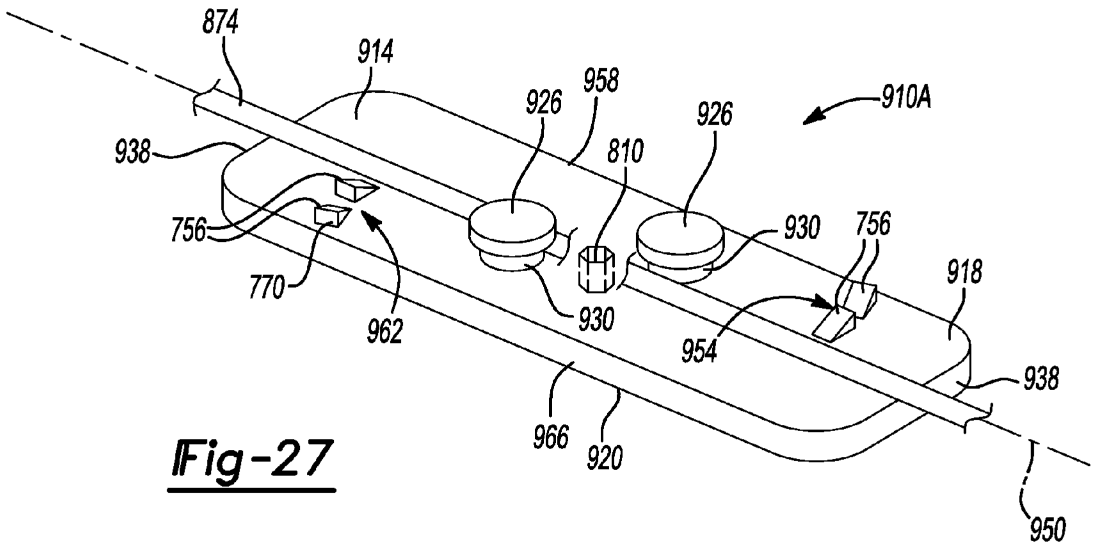


Fig-26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962
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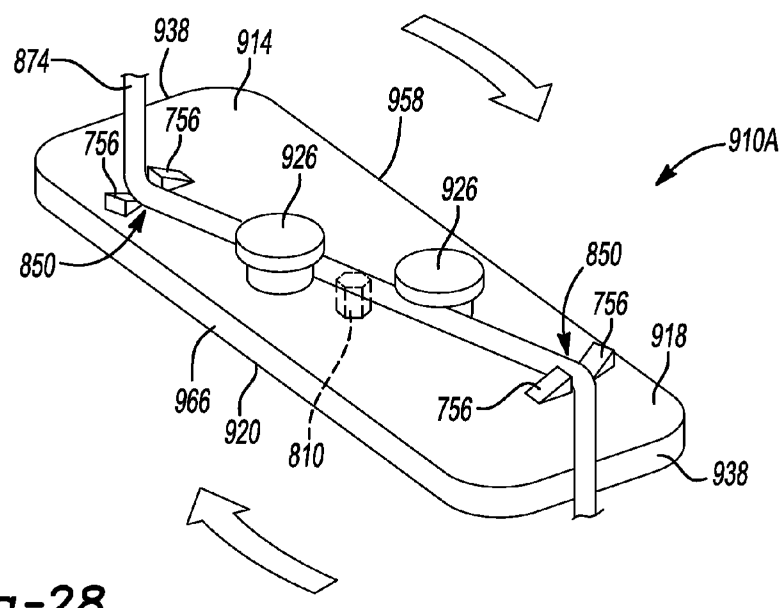
966
920
950

Fig-27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926
910A
926
850
850
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918
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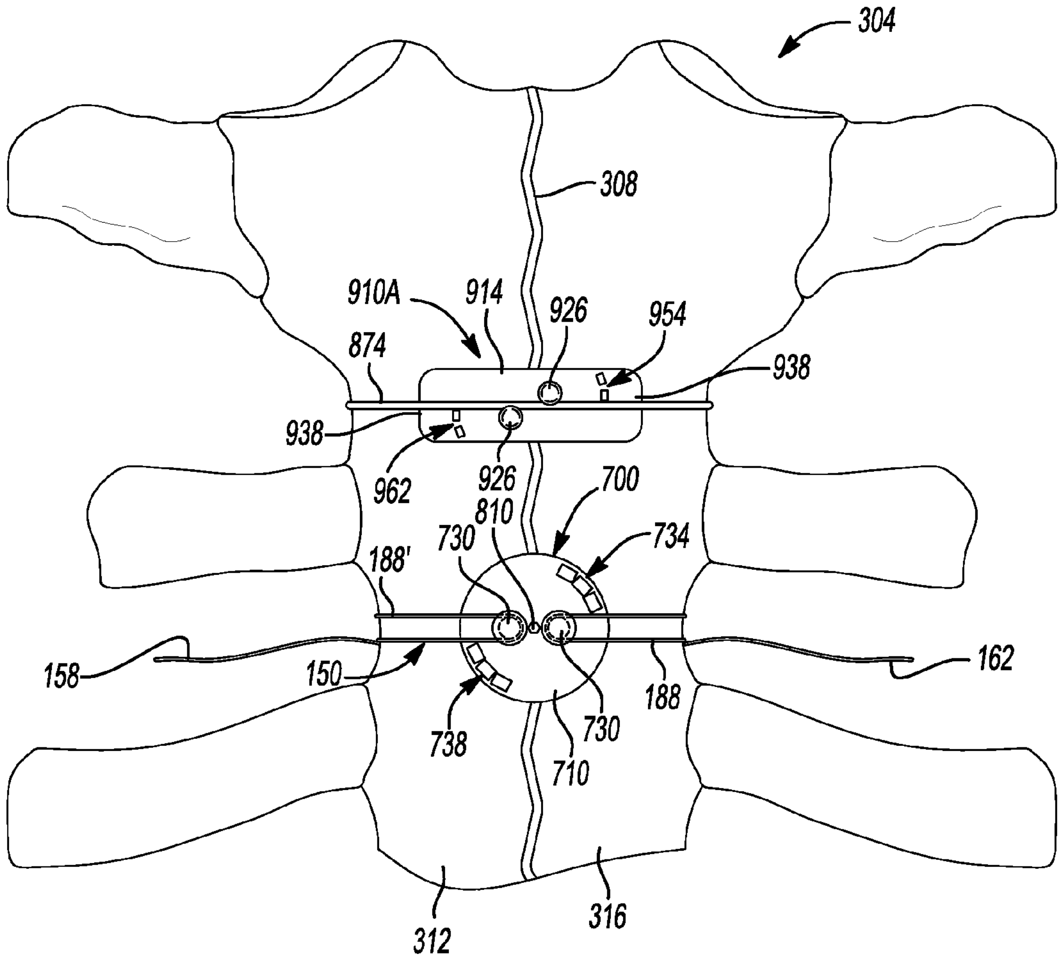
966
920
810
938

Fig-28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910A
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926
954
874
938
938
962
926
700
810
730
734
188'
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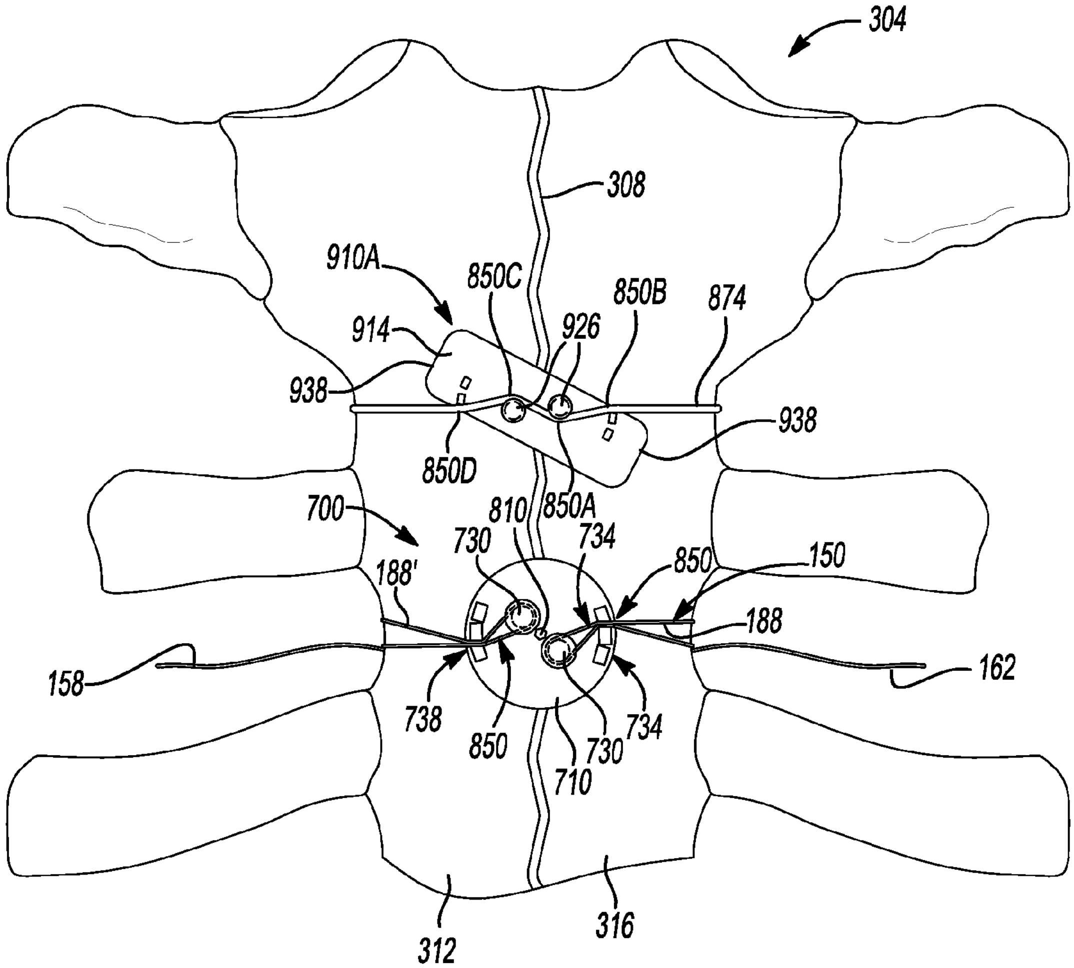
150
162
188
730
738
710
312
316

Fig-29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308
910A
850C
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874
914
926
938
938
850D
850A
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188
158
162
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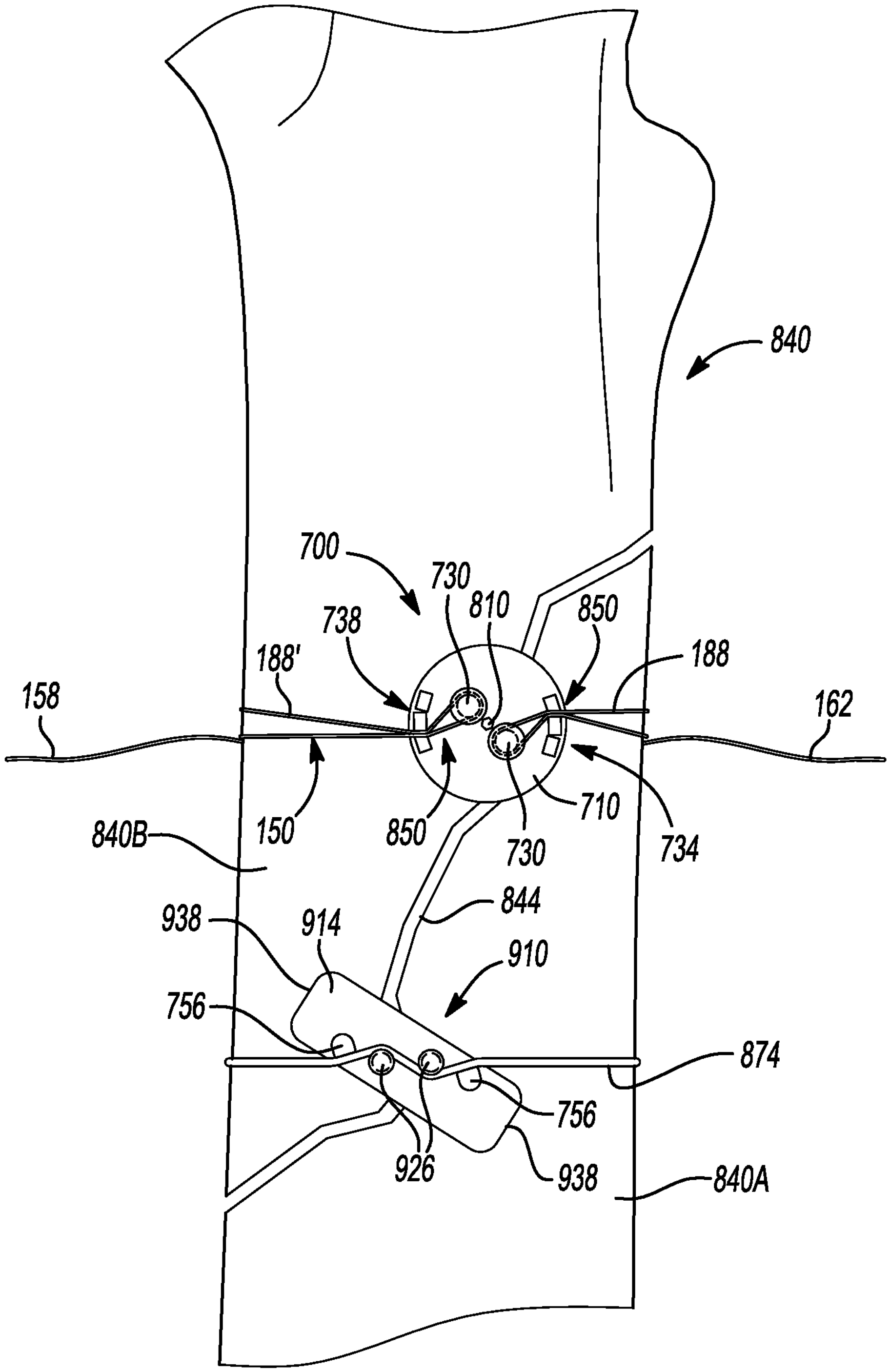
850
730
734
710
312
316

Fig-30


840
700
730
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738
188'
188
158
162
150
850
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710
734
840B
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938
914
910
756
874
756
926
938
840A

Fig-31

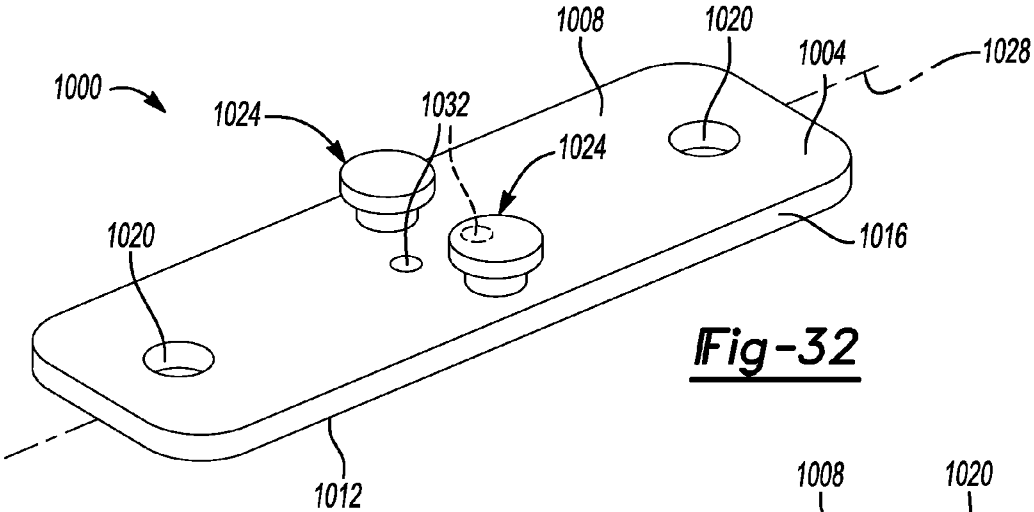


Fig-32

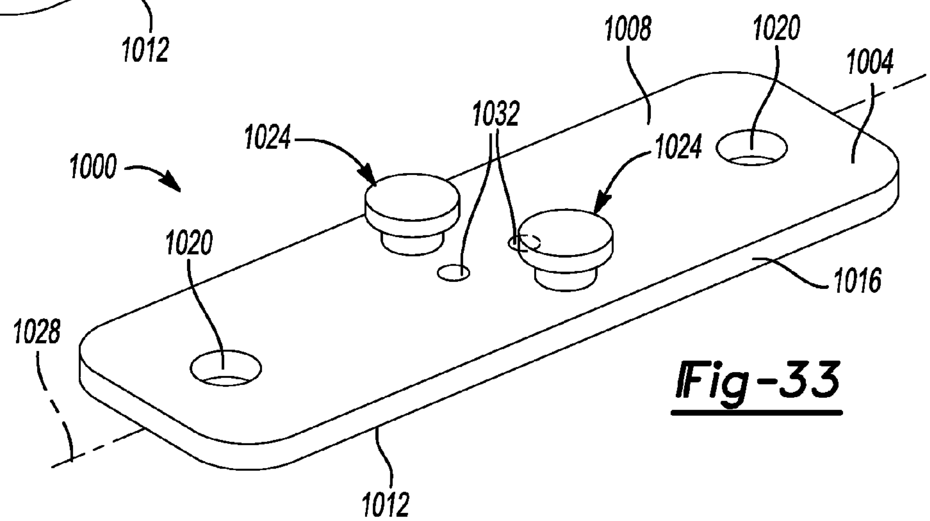


Fig-33

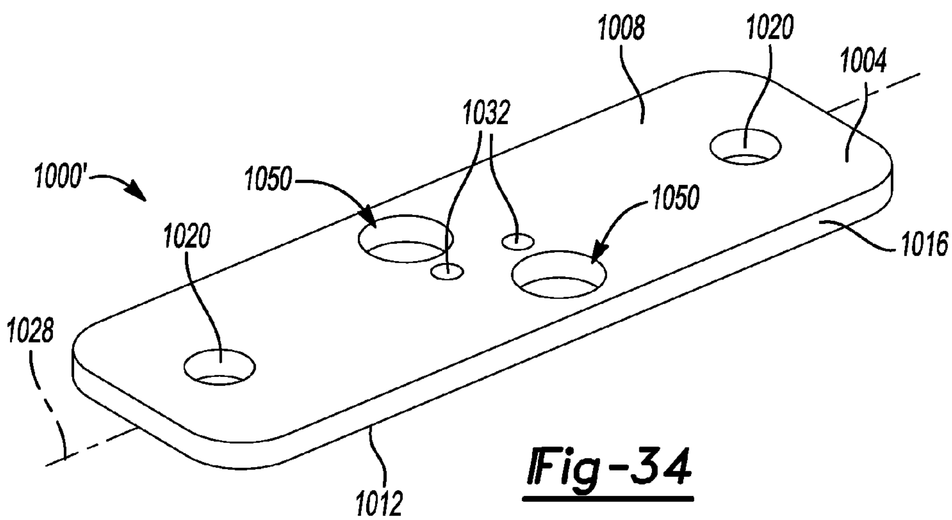
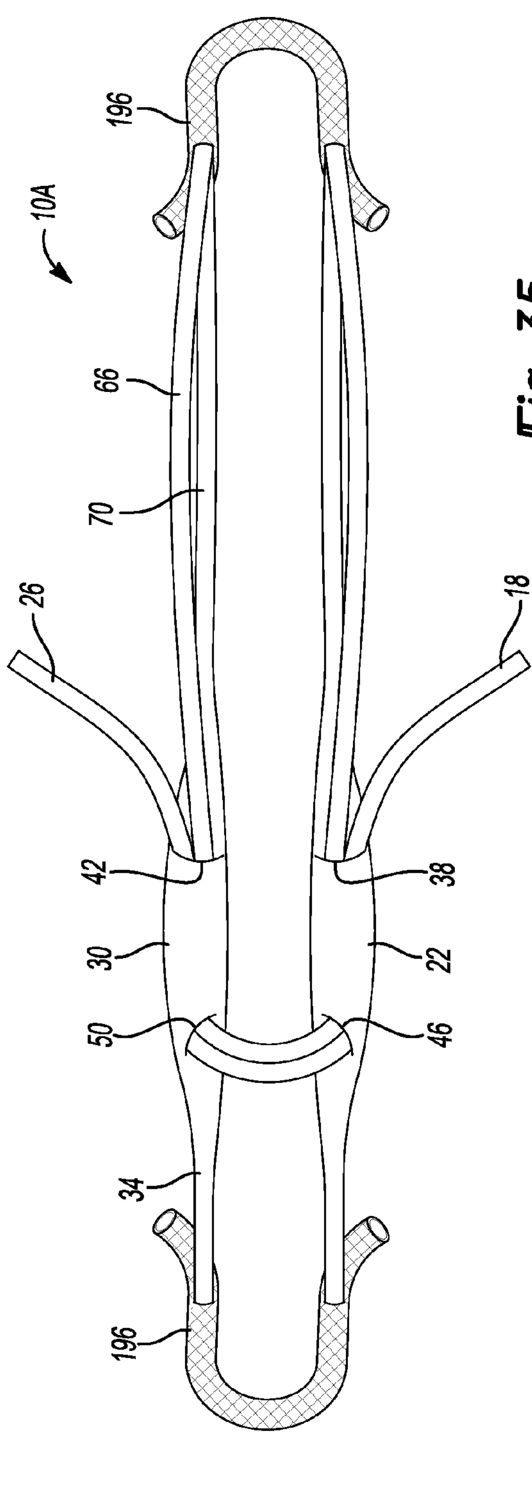
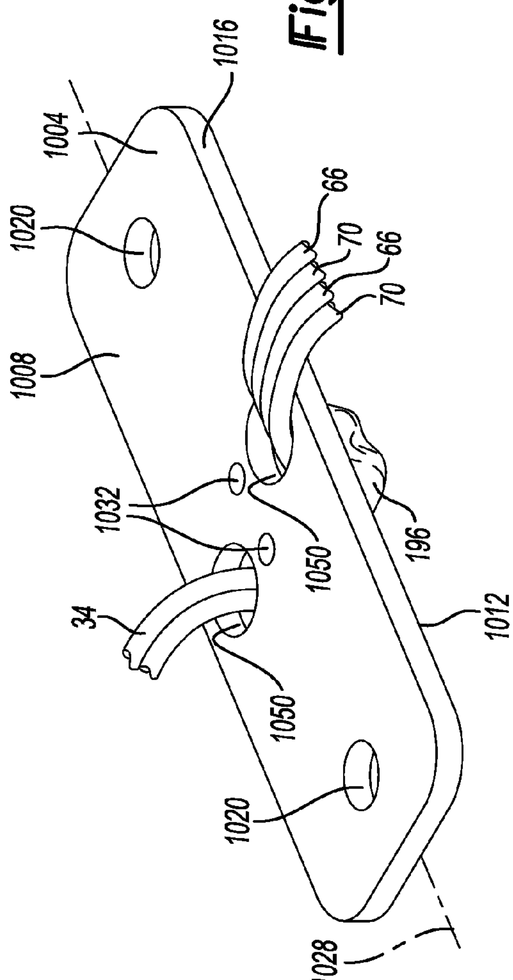


Fig-34



10A
196
66
70
26
18
42
38
30
22
50
46
34
196

Fig-35



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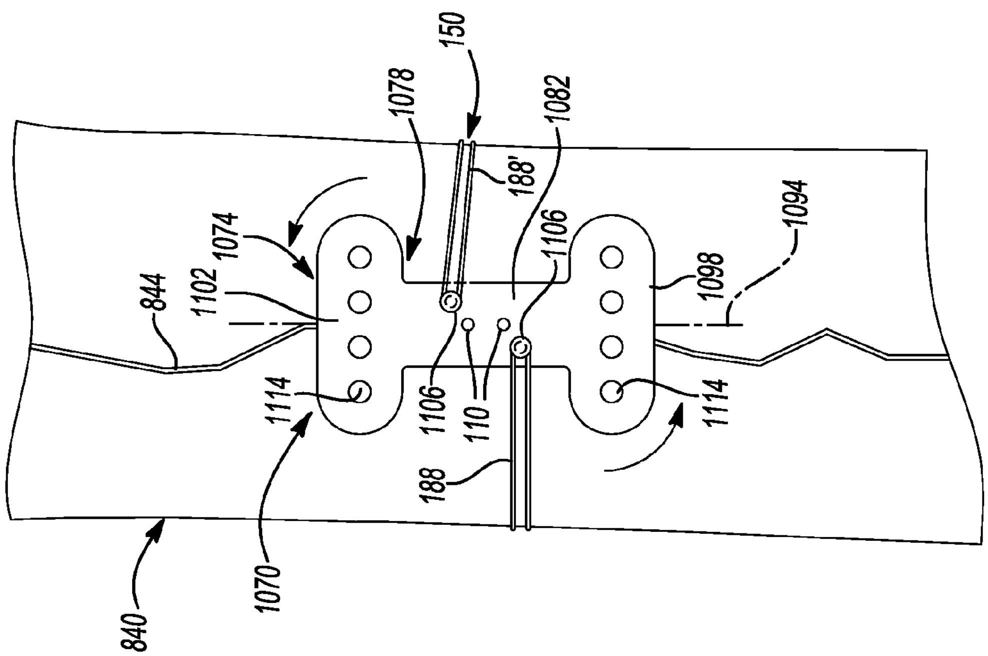
70
66
70
1008
1032
1050
196
34
1050
1012
1020
1028

Fig-36


150
1078
1082
188'
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1106
1074
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844
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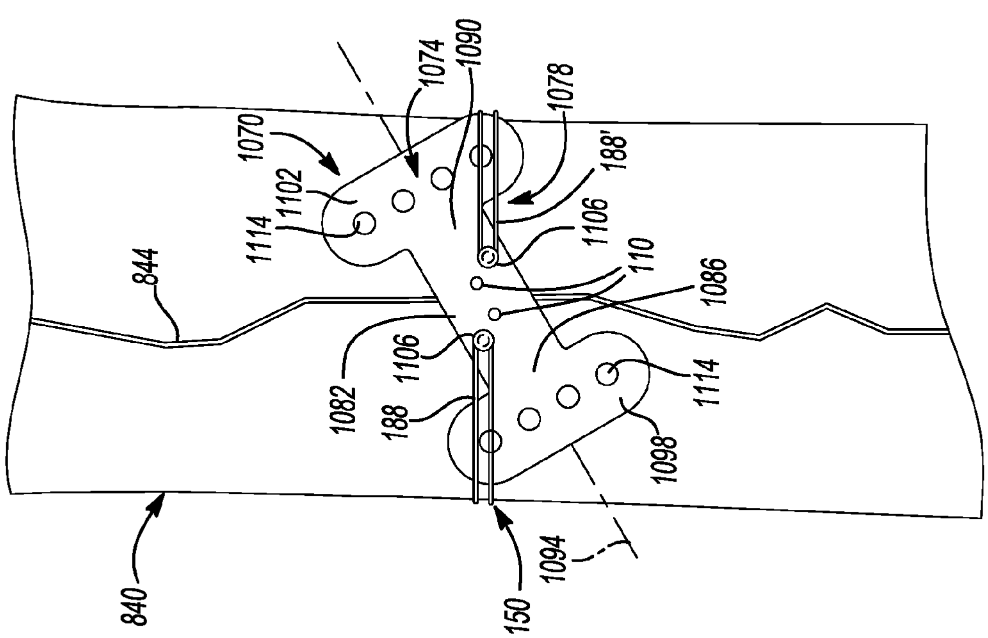
1106
110
1114
1114
188
1070
840

Fig-38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1074
1078
1070
1102
188'
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1106
110
844
1086
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1082
188
1114
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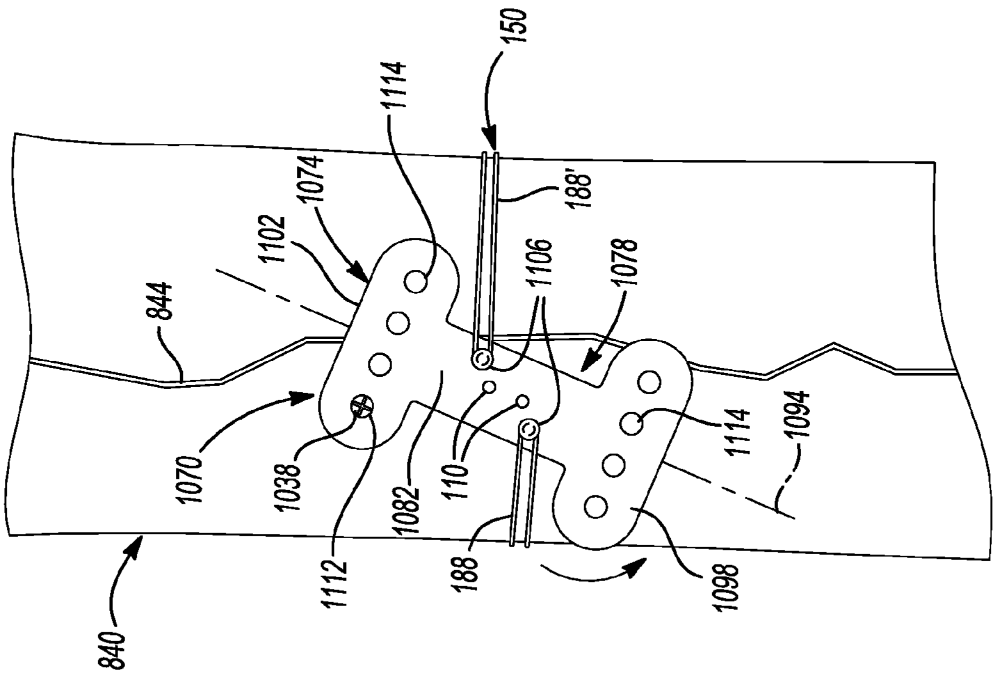
840
150
1094

Fig-37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1114
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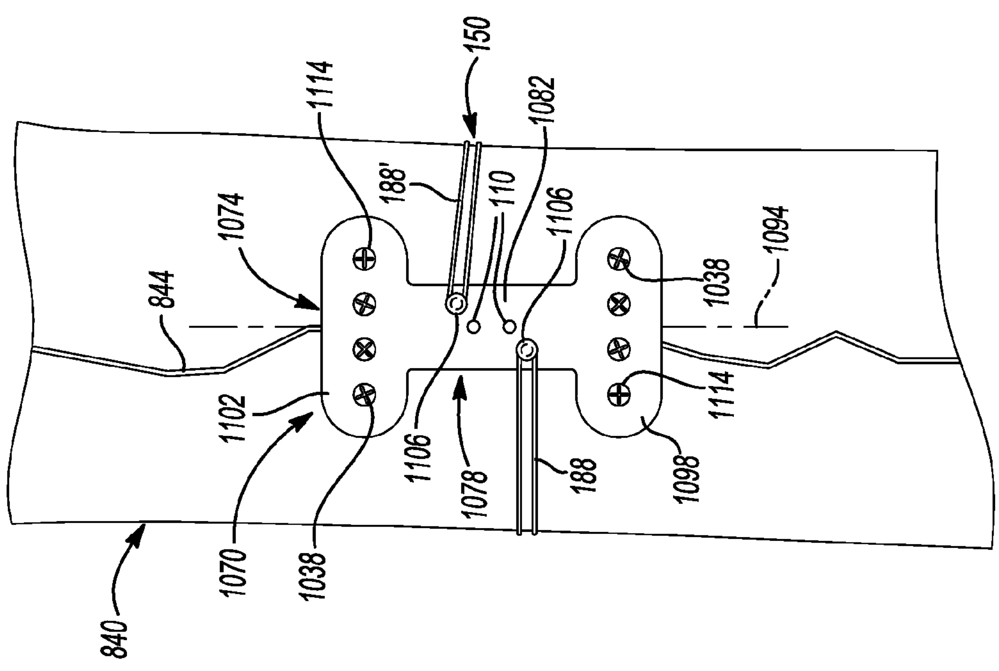
188
1098
840

Fig-40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188'
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188
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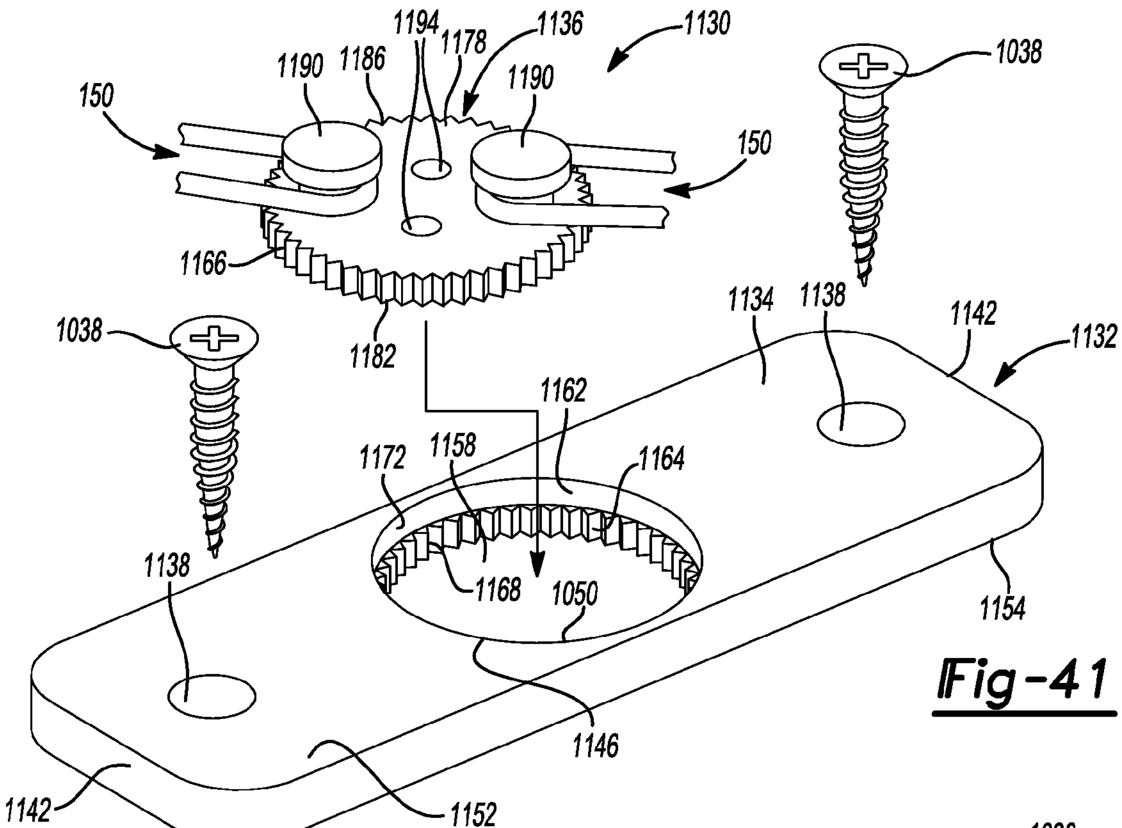
1070
1038
840

Fig-39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1138
1142
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Fig-41

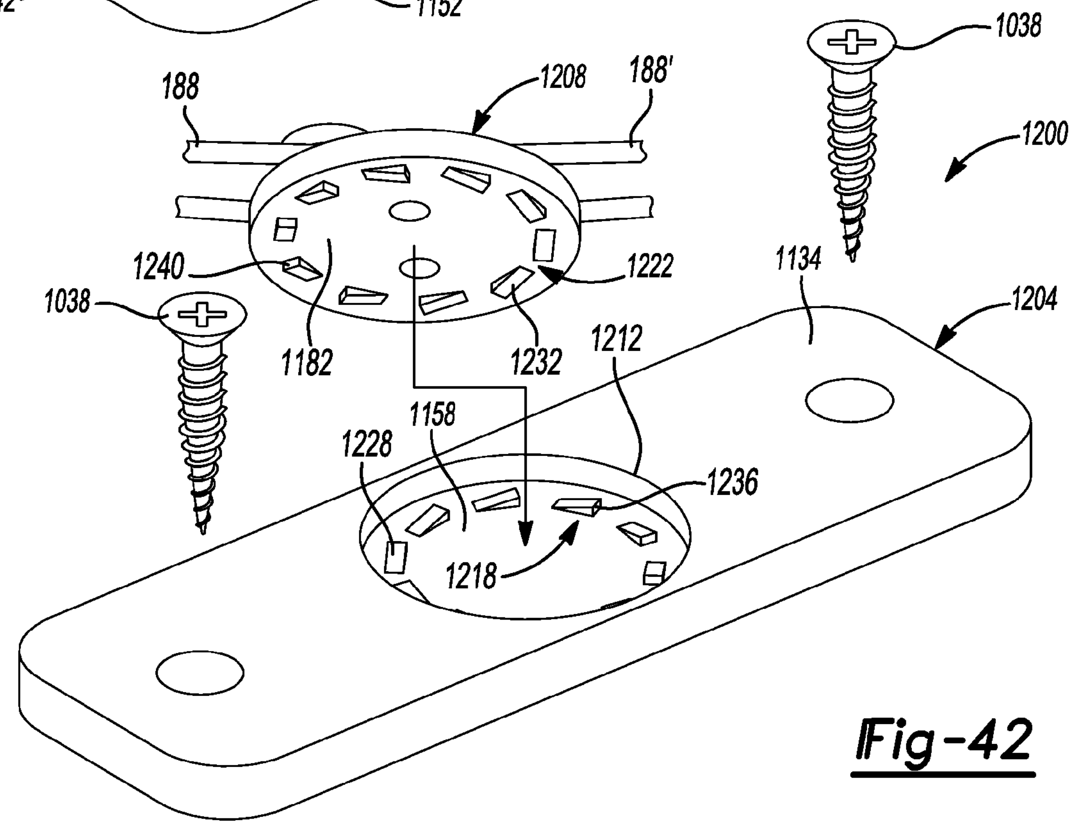
1038
188
1208
188'
1200
1240
1222
1134
1038
1204
1182
1232
1212
1158
1228
1236
1218

Fig-42

METHOD AND APPARATUS FOR TENSIONING A SUTURE

CROSS-RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 12/938,902 filed on Nov. 3, 2010, now issued as U.S. Pat. No. 8,597,327, which is a continuation-in-part of U.S. patent application Ser. No. 12/915,962 filed on Oct. 29, 2010, now issued as U.S. Pat. No. 8,562,647, which is a continuation-in-part of U.S. patent application Ser. No. 12/719,337 filed on Mar. 8, 2010, now issued as U.S. Pat. No. 9,078,644, which is a continuation-in-part of U.S. patent application Ser. No. 12/489,168 filed on Jun. 22, 2009, now issued as U.S. Pat. No. 8,361,113, which is a continuation-in-part of U.S. patent application Ser. No. 12/474,802 filed on May 29, 2009, now issued as U.S. Pat. No. 8,088,130, which is a continuation-in-part of (a) U.S. patent application Ser. No. 12/196,405 filed on Aug. 22, 2008, now issued as U.S. Pat. No. 8,128,658; (b) U.S. patent application Ser. No. 12/196,407 filed on Aug. 22, 2008, now issued as U.S. Pat. No. 8,137,382; (c) U.S. patent application Ser. No. 12/196,410 filed on Aug. 22, 2008, now issued as U.S. Pat. No. 8,118,836; and (d) a continuation-in-part of U.S. patent application Ser. No. 11/541,506 filed on Sep. 29, 2006, which is now U.S. Pat. No. 7,601,165 issued on Oct. 13, 2009.

This application is a continuation-in-part of U.S. patent application Ser. No. 12/570,854 filed on Sep. 30, 2009, now issued as U.S. Pat. No. 8,303,604, which is a continuation-in-part of U.S. patent application Ser. No. 12/014,399 filed on Jan. 15, 2008, which is now U.S. Pat. No. 7,909,851 issued on Mar. 22, 2011, which is a continuation-in-part of U.S. patent application Ser. No. 11/347,661 filed on Feb. 3, 2006, which is now U.S. Pat. No. 7,749,250 issued on Jul. 6, 2010.

This application is a continuation-in-part of U.S. patent application Ser. No. 12/029,861 filed on Feb. 12, 2008, now issued as U.S. Pat. No. 8,672,968, which is a continuation-in-part of U.S. patent application Ser. No. 11/504,882 filed on Aug. 16, 2006, which is a continuation-in-part of U.S. patent application Ser. No. 11/408,282 filed on Apr. 20, 2006, and now abandoned.

This application is a continuation-in-part of U.S. patent application Ser. No. 12/702,067 filed on Feb. 8, 2010, now issued as U.S. Pat. No. 8,672,968, which is a continuation of U.S. patent application Ser. No. 11/541,505 filed on Sep. 29, 2006 and is now U.S. Pat. No. 7,658,751 issued on Feb. 9, 2010.

This application is a continuation-in-part of U.S. patent application Ser. No. 13/102,182 filed on May 6, 2011, now issued as U.S. Pat. No. 8,231,654, which is a divisional of U.S. patent application Ser. No. 12/196,398 filed Aug. 22, 2008, now U.S. Pat. No. 7,959,650 issued on Jun. 14, 2011, which is a continuation-in-part of U.S. patent application Ser. No. 11/784,821 filed Apr. 10, 2007, now issued as U.S. Pat. No. 9,017,381.

The disclosures of all of the above applications are incorporated by reference herein.

FIELD

The present disclosure relates generally to methods and apparatus for tensioning a suture.

BACKGROUND

The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

After trauma or surgical intervention, there may be a need to fix bone fragments or portions together to immobilize the fragments and permit healing. Compressive force can be applied to the bone fragments by encircling the bone fragments or bridging the fragments together across a broken, sectioned (cut) or otherwise compromised portion of the bone. The compressive forces should be applied such that upon ingrowth of new bone, the fragments will heal together and restore strength to the site of trauma or surgical intervention.

Accordingly, there is a need for apparatus and methods to apply compressive force to a bone across a fracture or section (cut) to maintain alignment and assist healing. Further, there is a need for apparatus and methods that are easy to use intraoperatively to accommodate various bone sizes or shapes, or locations of bone fractures or sections.

SUMMARY

This section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope or all of its features.

In one aspect, an apparatus for applying tension to a suture is provided in accordance with the present teachings. The apparatus can include a tensioning member having a body, first and second suture attachment members and first and second suture engaging members. The body can define a first bone engaging surface, an opposite second suture receiving surface, and an outer perimeter. The first and second suture attachment members can be positioned relative to the second surface and spaced apart from each other, and can be adapted to be coupled to the suture. The first and second suture engaging members can extend from the second surface and can be positioned in spaced relation to the respective first and second suture attachment members. Rotation of the tensioning member in a first direction can be adapted to selectively engage the first and second suture receiving members with the suture, thereby forming a non-linear path of travel of the suture relative to the first and second suture attachment members and suture engaging members and increasing the tension in the suture.

In another aspect, a method for applying tension to a flexible member is provided in accordance with the present teachings. The method can include positioning a tensioning member relative to a first bone portion and a second bone portion, where the tensioning member can have first and second flexible member attachment members and a corresponding set of first and second flexible member engaging members extending therefrom. The flexible member can be positioned about the first and second bone portions and can be coupled to the first and second attachment members. The flexible member can be tensioned to draw the first and second bone portions toward each other under a first tension. The tensioning member can be rotated such that the first and second attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension. The flexible member can be engaged with the first and second flexible member engaging members and can create a non-linearity in the flexible member about each of the flexible member engaging members. The second tension can be maintained via engagement of the flexible member with the first and second attachment members and the first and second engagement members in an absence of an external force.

In yet another aspect, a method for applying tension to a suture is provided in accordance with the present teachings.

The method can include positioning a tensioning member relative to a first bone portion and a second bone portion, where the tensioning member can have first and second suture attachment members and a corresponding first and second plurality of suture engaging members extending therefrom. An adjustable suture construct can be positioned about the first and second bone portions. First and second adjustable loops of the adjustable suture construct can be coupled to the first and second attachment members. Free ends of the adjustable suture construct can be tensioned to reduce a size of the first and second adjustable loops and draw the first and second bone portions toward each other under a first tension. The tensioning member can be rotated such that the first and second attachment members draw the adjustable suture construct in opposite directions applying additional tension to the suture construct to place the suture construct and the first and second bone portions under a second tension. The first and second adjustable loops can be engaged with a respective one of the plurality of first and second suture engaging members and can create a non-linearity in the adjustable loops about each of the one of the plurality of first and second suture engaging members. The second tension can be maintained via engagement of the first and second adjustable loops with the first and second suture attachment members and the one of the plurality of first and second suture engagement members in an absence of an external force.

In still another aspect, a method for applying tension to a flexible member is provided in accordance with the present teachings. The method can include positioning a tensioning member in a first position relative to a first bone portion and a second bone portion, where the tensioning member can have first and second flexible member attachment members. The flexible member can be positioned about the first and second bone portions and can be coupled to the first and second attachment members. The flexible member can be tensioned to draw the first and second bone portions toward each other under a first tension. The tensioning member can be rotated to a second position such that the first and second attachment members draw first and second ends of the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension. The tensioning member can be secured in the second position to at least one of the first and second bone portions to maintain the second tension.

In another aspect, an apparatus for applying tension to a suture is provided in accordance with the present teachings. The apparatus can include a tensioning member having a first member and a second member. The first member can have a body defining a first bone engaging surface, an opposite second surface, and a pocket formed in the second surface and extending toward the first surface. The pocket can include a first retention arrangement. The second member can be sized and shaped to be received in the pocket and can include a first lower surface and a second upper surface. The second upper surface can include first and second suture attachment members spaced apart from each other. The first and second suture attachment members can be adapted to be coupled to the suture, where the second member can be configured to be positioned at least partially into the pocket and can include a second retention arrangement operable to engage the first retention arrangement. The second member can be configured to be rotated relative to the first member to impart tension onto the suture, wherein the first retention arrangement can be configured to engage the second retention arrangement to prevent rotation of the second member relative to the first member in at least one rotational direction.

In yet another aspect, a method for applying tension to a flexible member is provided in accordance with the present teachings. The method can include positioning a first member of a tensioning member assembly relative to a first bone portion and a second bone portion, where the tensioning member can include a pocket formed therein on an upper surface opposite a lower bone engaging surface. The flexible member can be positioned about the first and second bone portions and can be coupled to first and second attachment members associated with a second member of the tensioning member assembly. The second member can be rotated in a first rotational direction relative to the pocket of the first member to impart tension onto the flexible member. The second member can be positioned in the pocket of the first member such that a second retention arrangement associated with the second member engages a first retention arrangement associated with the pocket of the first member to prevent rotation of the second member relative to the first member in a second rotational direction opposite the first rotational direction to maintain the tension imparted onto the flexible member.

Further areas of applicability will become apparent from the description provided herein. The description and specific examples in this summary are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

DRAWINGS

The present teachings will become more fully understood from the detailed description, the appended claims and the following drawings. The drawings are for illustrative purposes only and are not intended to limit the scope of the present disclosure.

FIG. **1** depicts an adjustable flexible member construct according to the present teachings;

FIGS. **1**A and **1**B depict an exemplary method of assembling the adjustable flexible construct of FIG. **1** according to the present teachings;

FIG. **2** depicts an exemplary assembly configuration of the flexible member construct of FIG. **1** having an attachment member and an insertion member according to the present teachings;

FIG. **2**A depicts a side view of the attachment member of FIG. **2** according to the present teachings;

FIGS. **3**, **3**A and **3**B depict alternative flexible member constructs according to the present teachings;

FIGS. **4** and **5** depict exemplary views of the adjustable flexible member construct of FIG. **1** in a surgical procedure for sternal closure according to the present teachings;

FIGS. **6-9** depict views of exemplary alternative attachment members associated with one or more of the adjustable flexible member constructs according to the present teachings;

FIGS. **10** and **11** depict views of the attachment members of FIGS. **6-9** in exemplary configurations for use in a sternal closure procedure according to the present teachings;

FIG. **12** depicts a view of an exemplary use of the flexible member construct of FIG. **3**A in a surgical method for sternal closure according to the present teachings;

FIG. **13** depicts an exemplary alternative attachment member according to the present teachings;

FIG. **14** depicts exemplary configurations of the attachment member of FIG. **13** associated with various adjustable flexible member constructs according to the present teachings;

FIG. **15** depicts an exemplary surgical method for sternal closure according to the present teachings;

FIG. **16** depicts an exemplary surgical method for sternal closure according to the present teachings;

FIGS. **17-21** depict aspects of an exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIGS. **22-23** depict another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIGS. **24-25** depict another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIG. **26** depicts an exemplary instrument for adjusting the tensioning members according to the present teachings;

FIGS. **27-28** depict another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIGS. **29-31** depict exemplary use of the tensioning members in exemplary sternal closure and fracture fixation procedures;

FIGS. **32-33** depict aspects of another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIG. **34-36** depict aspects of another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIGS. **37-40** depict aspects of another exemplary tensioning member for tensioning a flexible member construct according to the present teachings;

FIG. **41** depicts another exemplary tensioning member for tensioning a flexible member construct according to the present teachings; and

FIG. **42** depicts another exemplary tensioning member for tensioning a flexible member construct according to the present teachings.

DETAILED DESCRIPTION

The following description is merely exemplary in nature and is in no way intended to limit the present disclosure, its application, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. While the disclosure generally relates to apparatus and associated methods for tensioning a suture in connection with a fractured or section bone, such as in a sternal closure procedure, the apparatus and methods of the present teachings can be used in connection with various other fracture fixation methods and/or other procedures where suture tensioning is required, such as for example, in tensioning soft tissue or portions of two separate bones.

Referring to FIG. **1**, an adjustable flexible member construct **10** is provided according to various aspects of the present teachings. The adjustable flexible member construct **10** can be fashioned from a flexible member **14** made of any biocompatible material including, but not limited to, non-resorbable polymers, such as polyethylene or polyester, resorbable polymers, and various combinations thereof. In various aspects, the adjustable flexible member construct **10** can include a hollow material or core to allow for appropriate tensioning, as will be discussed herein. In various aspects, the adjustable flexible member construct **10** can be a suture. In such aspects, the suture can be hollow or a braided or a multiple-filament braided suture structure having a hollow core. In various aspects, the suture can be resorbable. In various aspects, the adjustable flexible member construct **10** can define a substantially tubular hollow shape.

The adjustable flexible member construct **10** can include a first end **18**, a first formed passage portion **22**, a second end **26**, a second formed passage portion **30**, and a fixed length loop portion **34** connecting the first and second passage portions **22**, **30**, as shown in FIG. **1**. In one exemplary aspect, flexible member construct **10** can include an elongated body **32** having an exterior surface and an interior surface defining an elongated passage between the first and second ends **18**, **26**. The body **32** can define the first and second passage portions **22**, **30** and the fixed length portion **34** therebetween. Passage portions **22**, **30** can each include first apertures **38**, **42** positioned proximate one end thereof, and second apertures **46**, **50** positioned proximate a second opposite end thereof. The passage portions **22**, **30** can be formed to have a larger width or diameter than remaining portions of flexible member **14**, as shown for example in FIG. **1**. Alternatively, the passage portions **22**, **30** can be formed initially to have the same width or diameter as the remaining portions of flexible member **14**, later expanding in diameter during the construction process. In various aspects, the first and second apertures **38**, **42**, **46**, **50** can be formed during a braiding process of flexible member **14** as loose portions between pairs of fibers defining flexible member **14**, or can be formed during the construction process. Alternatively, the first and second ends can be pushed between individual fibers of the braided flexible member **14**, as will be discussed herein.

To form the adjustable flexible member construct **10**, first end **18** can be passed through second passage portion **30** via first and second apertures **42**, **50**, as generally shown in FIGS. **1**A and **1**B. In a similar manner, second end **26** can be passed through the first passage portion **22** via the first and second apertures **38**, **46**, as also shown in FIGS. **1**A and **1**B. Subsequently, as shown in FIG. **1**B with reference to FIG. **1**, first end **18** can be passed through the first passage portion **22** via second and first apertures **46** and **38**, respectively. First end **18** can follow a path that is opposite in direction to a path followed by a portion **54** of the flexible member **14** that has already passed through first passage portion **22** while following second end **26** through first and second apertures **38** and **46**. Similarly, second end **26** can be passed through the second passage portion **30** via second and first apertures **50** and **42**, respectively. First end **26** can follow a path that is opposite in direction to a path followed by a portion **58** of the flexible member **14** that has already passed through second passage portion **30** while following first end **18** through first and second apertures **42** and **50**. This results in portions **62**, **64** of flexible member **14** being positioned parallel or substantially parallel to portions **54**, **58** in passage portions **22**, **30**. Passing the first and second ends **18**, **26** though passage portions **22**, **30** as discussed above forms adjustable loops **66**, **70**, as shown in FIG. **1**. The first and second ends can be passed through the same apertures in each passage portion **22**, **30** or, alternatively, through separate apertures in each passage portion **22**, **30**.

The adjustable flexible member construct **10** can thus provide a double adjustable loop configuration via loops **66**, **70** while also providing portion **34**, which can have a fixed length between the passage portions **22**, **30**. As will be discussed in greater detail herein, this configuration can be used, for example, to couple an attachment member to loops **66**, **70** and couple fixed length portion **34** to either the attachment member or another device. In this manner, the amount of friction developed within the first and second passage portions **22**, **30** relative to and among portions **54**, **58**, **62** and **64** during adjustment of adjustable loops **66**, **70** is reduced as compared to that which would occur if the attachment member were coupled to the passage portion when the loops are being adjusted or reduced in size under tension.

With additional reference to FIGS. **2** and **2**A, adjustable flexible member construct **10** is shown in an exemplary assembly configuration **76** having an attachment member **80** coupled to a first side **84** of loops **66**, **70** opposite a second side **88** facing fixed length portion **34**. Attachment member **80** can include a generally T-shaped configuration having a first stem portion **92** defining an aperture **94** for receipt of loops **66**, **70** therein at one end, and a transversely extending cross portion **96** at a second opposite end. Transversely extending portion **96** can include opposed lateral ends **104** that include arcuate or curled portions **108**, as shown in FIG. **2**A. In various aspects, attachment member **80** can be used to secure a flexible member loop thereto by placing the loop over first portion **92** and under arcuate portions **108**, as shown for example in FIG. **4**.

The assembly configuration **76** can also include an optional grab member or handle **116** and a passing or needle member **118**. Handle **116** can be used to aid the surgeon in easily pulling ends **18**, **26** of construct **10** to reduce the size of loops **66**, **70**, as will be discussed in greater detail below. Handle **116** can include a first pair of apertures **120** positioned at opposed ends **124** of handle **116**, as shown in FIG. **2**. The first and second ends **18**, **26** can be passed or routed through apertures **120** and then through a central aperture **128**, where ends **18**, **26** can be secured to handle **116** by various methods, including a knot **132**, as also shown in FIG. **2**. The surgeon can use handle **116** to apply simultaneous tension to ends **18**, **26**, which can thereby evenly reduce or adjust loops **66**, **70** to a desired size or tension.

Operation of the adjustable flexible member construct **10** will now be described in greater detail with reference to an exemplary configuration where adjustable flexible member construct **10** is wrapped around or encircles a bone, such as a sternum, and fixed loop **34** is connected to attachment member **80**, as shown for example in FIG. **4**. It should be appreciated, however, that construct **10** can be used in various attachment configurations, other than the example discussed above, wherein tension is applied to construct **10** via fixed loop **34** and attachment member **80** in connection with reducing or adjusting the size of loops **66**, **70**.

Upon applying tension to ends **18**, **26**, with or without handle **116**, the loops **66**, **70** can be reduced to a desired size and/or placed in a desired tension by causing translation of ends **18**, **26** relative to passage portions **22**, **30**. Tension in fixed length loop portion **34** combined with the tension in adjustable loops **66**, **70** can cause the body **32** of flexible member **14** defining the passage portions **22**, **30** to constrict about the portions **54**, **58** and **62**, **64** of flexible member **14** passed therethrough. This constriction can reduce a width or diameter of each of the passage portions **22**, **30**, thereby forming a mechanical interface between exterior surfaces of the passed through portions of flexible member **14** and interior surfaces of the passage portions **22**, **30**. The static friction between the interior and exterior surfaces at the mechanical interface formed as a result of the constriction can prevent relative movement of portions **54**, **58**, and **62**, **64** relative to passages **22**, **30** and hence prevent relaxation of the tension in construct **10**, thereby preventing an increase in the size of loops **66**, **70**. Thus, adjustable flexible member construct **10** provides for “automatically” locking loops **66**, **70** in a reduced length or size under tension without requiring a knot.

Flexible member construct **10** can be provided in various sizes to accommodate differently sized bones, such as sternums, in different patients. In one exemplary configuration, fixed loop portion **34** can be provided in various sizes or lengths. Flexible member construct **10** can also be provided with flexible member **14** having various diameters, such as 30 thousandths of an inch or 37-40 thousandths of an inch. In one exemplary configuration, the 30 thousandths diameter flexible member **14** can be used, for example, where construct **10** is routed or passed through holes drilled in the bone so that flexible member **14** can be more easily manipulated during such routing. The larger 37-40 thousandths diameter flexible member **14** can be used, for example, where the construct **10** is wrapped around the sternum, as will be discussed herein. Forming the construct **10**, as well as other constructs discussed herein, with a larger diameter flexible member provides more surface area of the tensioned flexible member to engage the sternum or other bone, and thus distribute the compressive load over a greater area of the bone.

With additional reference to FIG. **3**, and FIG. **3**A, an exemplary alternative adjustable flexible member construct **150** is shown. Construct **150** can include a hollow flexible member **154** having a first end **158** and a second end **162**, and can include a body **164** that defines a longitudinal passage portion **168** therein between first and second ends **158**, **162**, as shown in FIG. **3**. The passage portion **168** can define a pair of apertures **172**, **176** at opposed ends thereof, similar to apertures **38**, **46** discussed above. To form construct **150**, the first end **158** can be passed through aperture **172** and passage portion **168** and out aperture **176** such that a portion **180** of flexible member **154** following first end **158** extends through passage portion **168**. In a similar manner, second end **162** can be passed through aperture **176** and passage portion **168** and out aperture **172** such that a portion **184** of flexible member **154** following second end **162** also extends through passage portion **168**. This configuration forms two loops **188** and **188'**, as shown in FIG. **3**. It should be appreciated that each of the first and second ends **158**, **162** can alternatively be pushed through a respective space defined between adjacent individual fibers of the braided flexible member **14** such that the respective spaces defined between fibers comprise apertures **172**, **176** in communication with an interior longitudinal passage.

The pulling of ends **158**, **162** can cause movement of portions **180**, **184** relative to passage portion **168**, and the loops **188**, **188'** can be reduced to a desired size or placed in a desired tension. Tension in loops **188**, **188'** can cause the body **164** defining the passage portion **168** to be placed in tension and therefore cause passage portion **168** to constrict about portions **180**, **184** passed therethrough. This constriction reduces the diameter of passage portion **168**, thus forming a mechanical interface between the exterior surfaces of portions **180**, **184** and an interior surface of passage portion **168**. This constriction results in static friction between the interior and exterior surfaces at the mechanical interface, causing the adjustable flexible member **154** to “automatically” lock in a reduced size or diameter configuration in which tension is maintained. Flexible member construct **150** with adjustable loops **188**, **188'** can be used to compress a fractured or sectioned bone, such as a sectioned sternum in a sternal closure procedure following open chest surgery, as will be discussed herein.

With additional reference to FIG. **3**A, adjustable flexible member construct **150** is shown having attachment members or flexible anchors **196** coupled to loops **188**, **188'**. Each loop can include various numbers of anchors coupled thereto, including more or fewer anchors **196** than shown. Each anchor **196** can define a hollow core and can include a pair of apertures **200**, **204** formed in a body **208** thereof in a similar manner as apertures **38**, **46** discussed above. Flexible member

154 can pass through first aperture 204 into the hollow core and out through the second aperture 200, as shown in FIG. 3A. Apertures 200, 204 can be placed inward from respective ends 212, 216 of anchors 196 so as to form tail portions 220, 224 adjacent each aperture 200, 204. The tail portions 220, 224 can provide anchoring resistance relative to a corresponding bone or anchoring structure, as will discussed herein.

With reference to FIG. 3B and continuing reference to FIGS. 3 and 3A, an alternative adjustable flexible member construct 150A is shown. Construct 150A can be formed to include a double loop configuration having two loops 240, 240' that each traverse a path from one end of passage portion 168 to the other end thereof, instead of each loop being disposed at respective opposite ends of passage portion 168 as in construct 150. Flexible member construct 150A can be formed by passing the first end 158 of the flexible member through aperture 176, through passage portion 168 and out aperture 172. The second end 162 can be passed through aperture 172, through the passage portion 168 and out the aperture 176. In various aspects, the first and second apertures 172, 176 can be formed during the braiding process as loose portions between pairs of fibers defining the flexible member 154, as discussed above. Passing ends 158, 162 through the apertures 172, 176 can form the loops 240, 240'. The loops 240, 240' can define mount or summit portions 244, 244' of the adjustable flexible member construct 150A and can be disposed generally opposite from the passage portion 168. Flexible member construct 150A can be used, for example, to compress a fractured or sectioned bone or to close a sectioned sternum in sternal closure procedures, as will be discussed herein.

The longitudinal and parallel placement of the first and second ends 158 and 162 of the flexible member 154 within the passage portion 168 resists the reverse relative movement of the first and second portions 180, 184 of the flexible member construct 150A once it is tightened. The tensioning of the ends 158 and 162 can cause relative translation of the portions 180, 184 relative to passage portion 168. Upon applying tension to the first and second ends 158 and 162, the loops 240, 240' can be reduced to a desired size or placed in a desired tension. Tension in the loops 240, 240' can cause the body of the flexible member 154 defining the passage portion 168 to be placed in tension and therefore cause passage portion 168 to constrict about the portions 180, 184 similarly to the constriction discussed above with respect to construct 150. This constriction can cause the adjustable flexible member construct 150A to "automatically" lock in a reduced size or smaller diameter configuration. A further discussion of the flexible member constructs 150, 150A are provided in U.S. patent Ser. No. 11/541,506 filed on Sep. 29, 2006 entitled "Method and Apparatus for Forming a Self-Locking Adjustable Suture Loop" assigned to Biomet Sports Medicine, LLC, and the disclosure is incorporated by reference.

Referring now to FIGS. 4-16, the use of flexible member constructs 10, 150 and 150A in various assembly configurations and exemplary sternal closure procedures will now be described. With particular reference to FIGS. 4 and 5, a sternum 304 is shown having a section or cut 308 separating sternal portions 312, 316, such as may be performed in connection with cardiac surgery. Flexible member constructs 10, 150, 150A alone, or in various combinations with each other or additional fixation devices, can be used to compress and secure sternal portions 312, 316 together to assist healing, as will be discussed herein.

In FIGS. 4 and 5, adjustable flexible member construct 10 is shown in various configurations to compress sternal portions 312, 316 toward each other to close section 308. In one exemplary configuration, two flexible member constructs 10 can be used in a diagonal pattern in the manubrium 320 of the sternum in connection with two pairs of diagonally opposite holes 324 formed in the manubrium 320. While the diagonal pattern of flexible member construct 10 is shown in the manubrium 320 in FIG. 4, a non-diagonal or medial-lateral configuration can alternatively be used, as generally shown in FIG. 5.

To secure flexible member construct 10 to the manubrium 320, passing member 118 can be inserted through a first hole 324*a* of a respective pair of holes 324*a*, 324*b* and directed towards a corresponding second hole 324*b*, as shown in FIG. 5. A surgeon or the like can pull the passing member through the second hole 324*b* thus routing at least the fixed portion 34 through the first and second holes 324*a*, 324*b*. Fixed portion 34 can then be secured to attachment member 80, as shown in FIG. 4. Once fixed portion 34 is secured to the attachment member, first and second ends 18, 26 can be pulled or tensioned to reduce the loops 66, 70 to a desired size and to place construct 10 in a desired tension to compress and close the sectioned sternum 304. Ends 18, 26 of construct 10 can be tensioned by pulling on the respective ends as discussed above, or with the use of the handle 116, as generally shown in FIG. 4. Handle 116 can provide the surgeon with an ability to easily tension ends 18, 26 simultaneously and evenly. Handle 116 can then be removed and discarded. Handle 116 can be used to evenly tension loops 66, 70 as discussed above, or can be used to tension loops 66, 70 at different rates by manipulating an angle of handle 116 so that, for example, a first loop of loops 66, 70 can be tensioned at a faster rate than a second loop of loops 66, 70. In this manner, the first loop can reach a desired final tension before the second loop. In one exemplary configuration, the smaller diameter flexible member can be used with construct 10 in manubrium 320 for easier manipulation through holes 324.

Flexible member construct 10 can also be used to compress a body 332 of sternum 304, as also shown in FIGS. 4 and 5. For the body 332, construct 10 can be wrapped around the sternum and fixed portion 34 can be secured to attachment member 80 such that ends 18, 26 extend from an anterior side 336 of body 332, as shown in FIG. 4. In the exemplary configuration shown in FIG. 4, three flexible member constructs 10 are shown securing the body 332 of the sternum 304. Nevertheless, more or fewer flexible constructs than shown can be used in the intercostal spaces between the ribs to secure the body of the sternum, as may be determined by a surgeon during a sternal closure procedure. In addition, the larger diameter flexible member construct 10 can be utilized in body area 332 of sternum 304, according to one exemplary configuration. The larger diameter flexible member can enable more tension to be applied to the bone or sternum without cutting into or damaging the bone.

The flexible member constructs 10 can be attached and tensioned or secured to the sternum 304 in various orders. For example, flexible member constructs 10 can first be attached to the manubrium 320 and then to the body 332, or vice-versa. Additionally, flexible member constructs 10 can be tensioned in various orders, such as initially tensioning each flexible member construct 10 to a snug or non-slack condition and then further tensioning each construct 10 to a final desired tension. As discussed above, constructs 10 can be tightened with or without use of handle 116. Flexible construct 10 can automatically lock under tension, as also discussed above, after which a portion of ends 18, 26 can be trimmed and removed.

Flexible member construct **10** also can be provided with an antibiotic and/or platelet concentrate coating to resist bacterial adhesion and/or promote healing. In this regard, flexible member construct **10**, as well as other constructs discussed herein, can be pre-configured with such a coating or the coating can be applied intraoperatively. Further, the surgeon can also apply the platelet coating to the sectioned area during the sternal closure procedure.

With additional reference to FIGS. **6** and **10**, flexible member construct **150**A is shown in an assembly configuration **350** having a pair of attachment members **354** coupled to opposed sides **356** of loops **240** and **240'**. Attachment members **354** can include a generally arcuate shape **358** and, in the exemplary configuration shown in FIG. **6**, a generally semi-circular shape or U-shape. The shape **358** of attachment members **354** can be used to secure the attachment members **354** to medial and lateral sides **362** of sternum **304**, as generally shown in FIG. **10**. Attachment members **354** can include an aperture **366** for receiving loops **240**, **240'** therethrough, as shown in FIG. **6**. In an exemplary configuration, flexible member construct **150**A can be formed integrally with attachment members **354** for use in a sternal closure or other fracture reduction procedure. In this manner, attachment members **354** can be preformed and coupled to loops **240**, **240'** to form assembly configuration **350**, which can be provided in the assembly configuration for use in the sternal closure procedure.

With particular reference to FIG. **10**, construct **150**A in the assembly configuration **350** can be used to compress the sternum **304** by securing attachment members **354** to the sides **362** of sternal portions **312**, **316** and then applying tension to ends **158**, **162** of construct **150**A. The adjustable loops of construct **150**A can then be reduced to the desired size and placed in the desired tension to compress sternum **304** about section **308**. Flexible member construct **150**A can automatically lock under tension to maintain the reduced size of loops **240**, **240'**, as discussed above. It should be appreciated that while attachment members **354** are described above in connection with flexible member construct **150**A, the attachment members **354** can also be used with alternative flexible member constructs, such as construct **150**.

Turning now to FIG. **7** and with reference to FIG. **10**, flexible member construct **150** is shown in an assembly configuration **376** operatively associated with an attachment member or frame **380**. Frame **380** can be used to facilitate securing flexible member construct **150** around a fractured bone or the sectioned sternum **304** to compress the fracture or section and affect healing. Frame **380** can include a pair of attachment portions **384** at opposed ends **388** of the frame. In the exemplary configuration shown, frame **380** can include a generally rectangular plate **392** and the attachment portions **384** can be in the form of V-shaped apertures extending through plate **392** from a top surface **396** to a bottom surface **400**, as shown in FIG. **7**. Bottom surface **400** can optionally include a pair of fixation members **404** to prevent movement of frame **380** relative to the sternum **304** upon placement thereon. Fixation members **404** can include spikes, posts, screws, adhesive or the like that are coupled to or pass through or extend from the bottom surface **400**.

With additional reference to FIG. **10**, flexible member construct **150** in the assembly configuration **376** is shown with the bottom surface of frame **380** positioned on the anterior side **336** of sternum **304**. Flexible member construct **150** can then be wrapped around sternum **304** and opposed ends **412** of loops **188**, **188'** can be secured to frame **380** via attachment portions **384**. In this configuration, passage portion **168** can be positioned on a posterior side of sternum **304**, as generally shown in FIG. **10**. Ends **158**, **162** of construct **150** can then be tensioned to reduce the loops **188**, **188'** to the desired size and tension to compress and close section **308** and assist healing of sternum **304**. Flexible member construct **150** can automatically lock and maintain the reduced size of loops **188**, **188'** under tension, as discussed above. It should be appreciated that frame **80** can also be used with flexible member construct **10**.

Referring now to FIGS. **8** and **10**, flexible member construct **150** is shown in an assembly configuration **420** operatively associated with an attachment member or frame **430**. Frame **430** can include a base **434**, a post **438** extending from an upper surface **442** of base **434**, and at least one optional fixation member **446** extending from a lower surface **448** of base **434**. Fixation member **446** can include spikes, posts, screws, adhesive or the like that are coupled to or extend from lower surface **448**. Post **438** can include a reduced diameter neck portion **450** coupled to the base and a larger diameter or head portion **454** coupled to the neck portion **450** and configured to retain loops **188**, **188'** of construct **150**, as discussed below. Frame **430** can be placed on sternum **304** with lower surface **448** engaging the anterior side **336** of sternum **304**, as shown in FIG. **10**. Flexible member construct **150** can be wrapped around sternum **304** in one of the intercostal spaces and each loop **188**, **188'** can be secured to the frame **380** via post **438**, as also shown in FIG. **10**.

In this exemplary configuration, passage portion **168** can be positioned on the posterior side of sternum **304**. Once frame **430** is positioned and construct **150** is wrapped around the sternum and secured to post **438**, ends **158** and **162** extending from the posterior side of sternum **304** can be tensioned. Applying tension to ends **158**, **162** can reduce loops **188**, **188'** to a desired size and tension to compress sectioned sternal portions **312**, **316** together to assist healing at section **308**, as generally shown in FIG. **10**. Flexible construct **150** can automatically lock loops **188**, **188'** under tension to maintain the reduced size of loops **188**, **188'** and compression of sternal portions **312**, **316** together, as discussed above.

It should be appreciated that while reference to FIG. **10** has been made with respect to the assembly configurations **350**, **376** and **420**, these assembly configurations have been combined in one figure for illustration purposes only and need not be used together. In this regard, an exemplary sternal closure procedure could utilize only one of the assemblies shown in the intercostal spaces, or combinations thereof, as may be desired by a particular surgeon performing a sternal closure procedure. It should also be appreciated that assemblies **350**, **376** and **420** could be used individually or in various combinations with flexible member constructs **10** secured to the manubrium **320**, as discussed above with reference to FIG. **4**.

Referring now to FIGS. **9** and **11**, adjustable flexible member construct **150** is shown in an assembly configuration **468** operatively associated with a frame **472**. As shown in FIG. **9**, frame **472** can include a generally rectangular body **476** with attachment portions **480** positioned at one pair of diagonally opposed corners **484** and a groove or channel **486** extending diagonally across a top surface of frame **472** from a second pair of opposed corners **488**. While frame **472** is shown having rectangular body **476**, it should be appreciated that frame **472** can be configured in other shapes, such as various polygonal shapes for use in coupling frame **472** to flexible member construct **150**, as will be described below. Attachment portions **480** can each include a recess **492** at least partially surrounding a post **496**. Post **496** can include a neck portion **500** and a cap or head portion **504** having a width dimension **508** greater than a corresponding width of neck portion **500** such that at least a portion of head portion **504** overhangs neck portion **500**, as shown in FIG. **9**. At least one optional fixation member **512** can extend from a bottom surface **516** of frame **472**.

With particular reference to FIG. **11**, frame **472** can be positioned in various configurations relative to sternum **304**, as illustrated by the two exemplary configurations shown in FIG. **11**. Frame **472** can be positioned on sternum **304** such that the bottom surface **516** engages the anterior side **336** of sternum **304**. Flexible member construct **150** can be wrapped around sternum **304** within an intercostal space thereof and loops **188**, **188'** can be coupled to respective attachment portions **480**. More specifically, flexible construct **150** can be placed in channel **486** such that passage portion **168** is positioned within channel **486**, as shown in FIG. **11**. Positioning construct **150** in channel **486** can provide a low profile closure arrangement that can be more conformable or provide less discomfort to a recipient patient. Loop portion **188** can then be wrapped around the posterior side of sternum **304** in one direction and coupled to attachment portion **480**A of the pair of attachment portions **480**. Similarly, loop portion **188'** can be wrapped around the posterior side of sternum **304** in an opposite direction of loop **188** and then be coupled to attachment portion **480**B. Tension can then be applied to ends **158**, **162** to reduce the size of loops **188**, **188'** to compress sternal portions **312**, **316** together to assist healing of sectioned sternum **304** at section **308**. Flexible member construct **150** can automatically lock loops **188**, **188'** at the desired reduced size under tension, as discussed above. In addition, placing frame **472** over the section can also stabilize the sternum to align sternal portions **312**, **316** to be co-planar.

Flexible member construct **150** in the assembly configuration **468** can be used alone or in various combinations with flexible member constructs **10** and **150**A and/or assembly configurations **350**, **376** and **420** discussed above. For example, flexible member constructs **10** can be used in the manubrium **320** as shown in FIG. **4** and assembly **468** can be used alone or in various combinations with assemblies **350**, **376** and **420** in the body **332** to compress sternal portions **312**, **316**, as discussed above.

Referring now to FIG. **12**, adjustable flexible member construct **150** is shown operatively associated with anchors **196** and an orthopedic mesh **550** for use in a sternal closure procedure. More particularly, orthopedic mesh **550** can be positioned on the anterior side **336** of sternum **304** such that portions **554** extend around the lateral sides **362** in the intercostal spaces, as shown in FIG. **12**. The orthopedic mesh **550** can be, for example, a product sold by Biomet Sports Medicine, LLC under the name SportMesh™. With the orthopedic mesh **550** positioned on sternum **304** as discussed above, construct **150** with anchors **196** can be used in various configurations to compress the sectioned sternum **304** at section **308**, as generally shown in FIG. **12**.

The orthopedic mesh **550** can be coated with the platelet concentrate discussed above, and/or antibiotics, bone growth agents, etc. to aid in soft tissue healing. The mesh **550** can provide a barrier between the flexible member constructs and the bone to aid in transferring load from the flexible member construct to the mesh **550**, which can decrease the pressure applied to the bone by the tensioned flexible member construct. The mesh **550** can be particularly useful, for example, in patients with soft bone tissue. It should also be appreciated that load distribution in the intercostal spaces can be provided by the portions **554** that extend around the medial and lateral sides. Moreover, the orthopedic mesh can aid in the retention of anchors **196**, particularly where the bone tissue may be soft.

In one exemplary configuration, four holes **558** can be formed through the mesh **550** and the manubrium **320**. Flexible anchors **196** associated with two flexible member constructs **150** can be inserted through respective diagonal pairs of holes **558** through the manubrium, as shown in FIG. **12**. The constructs **150** can be in diagonal overlapping pattern and be disposed primarily on top of the orthopedic mesh **550**. Upon tensioning the free ends **158**, **162** of each construct **150**, the tail portions **220**, **224** of anchors **196** can engage the posterior manubrium adjacent holes **558** and provide anchoring resistance to retain the anchors **196** outside of holes **558** on the posterior side of the sternum **304**. The loops **188**, **188'** subsequently can be reduced to the desired size or tension to compress sternal portions **312**, **316** and assist closure and healing of the sectioned sternum. The orthopedic mesh **550** can work to distribute the load placed on the anterior side **336** of the sternum by the constructs **150** under tension. A similar configuration **562** can be used at a lower portion **566** of the sternum **304** adjacent the Xiphoid process, as also shown in FIG. **12**. It should be appreciated that configuration **562**, as well as the configuration discussed immediately above with respect to the manubrium, can alternatively be in a parallel transverse pattern as opposed to the illustrated diagonal patterns.

Continuing with FIG. **12**, adjustable flexible construct **150** having a pair of anchors **196** attached to respective loops **188**, **188'** can be inserted through transverse bores **586** formed in sternum **304**. In particular, the constructs **150** can be positioned in bores **586** such that the passage portions **168** are each aligned in a respective bore **586**, as shown in FIG. **12**. The constructs **150** can be pierced or routed through the portions **554** of orthopedic mesh **550** that extend around the lateral sides of sternum **304** so as to provide additional anchoring resistance and load distribution for flexible anchors **196**, as shown in FIG. **12**. Ends **158**, **162** can be tensioned to compress sternal portions **312**, **316**, as discussed herein. It should be appreciated that while orthopedic mesh **550** is shown in FIG. **12** with reference to construct **150** and flexible anchors **196**, orthopedic mesh **550** can be used in various other sternal closure configurations disclosed herein, for example, to distribute a load applied by the various disclosed flexible member constructs relative to the sternum **304**.

Referring now to FIGS. **13** and **14**, adjustable flexible member construct **150** is shown in exemplary assembly configurations **600** and **604** operatively associated with attachment members **608**. Each attachment member **608** can include a body **612** having a substantially U-shaped configuration and can be sized for positioning about the lateral sides **362** of sternum **304** such that top and bottom portions **616**, **620** extend about the respective anterior and posterior sides of the sternum, as shown in FIG. **14**. In one exemplary configuration, attachment member **608** can include an aperture **624** positioned within a side portion **628** connecting the top and bottom portions **616**, **620**. In another configuration, attachment member **608** can include an aperture **632** in the top portion **616**, as shown in FIG. **14**. Aperture **632** can be in lieu of or in addition to aperture **624**.

With reference to assembly configuration **600**, flexible member construct **150** with anchors **196** can be positioned through transverse bore **636** in sternum **304** such that passage portion **168** is positioned within the bore. Each respective loop **188**, **188'** with anchors **196** can be passed through aperture **624** in attachment member **608** such that the anchors **196** are on a first side of portion **628** opposite a second side adjacent the sternum **304**. Ends **158**, **162** can then be tensioned thereby reducing a size of loops **188**, **188'** so as to draw attachment members **608** against the lateral sides of sternum

304 and compress sternal portions 312, 316 together. Flexible member construct 150 can automatically lock the loops in the reduced diameter configuration under tension, as described herein. Attachment members 608 can facilitate distributing a compression load applied to the sternum by the tensioned construct 150, which can enable more tension to be applied.

With continuing reference to FIG. 14, assembly configuration 604 can include attachment members 608 integrally formed or pre-assembled with flexible member construct 150A such that loops 240, 240' are coupled to apertures 632. In this configuration, attachment members 608 can be positioned against the respective lateral sides of sternum 304, similar to assembly configuration 600 discussed above. Flexible member construct 150A can be positioned relative to the anterior side 336 of sternum 304 such that it does not wrap around or extend through sternum 304. It should be appreciated that assembly configurations 600, 604 can be used alone or with various other flexible member construct and assembly configurations disclosed herein to compress sternal portions 312, 316 to assist healing of sectioned sternum 304.

Turning now to FIG. 15, an alternative configuration 650 for compression of sternum 304 in a sternal closure procedure is provided. Configuration 650 can include two flexible member constructs 10 in a transverse orientation in the manubrium 320, as generally discussed above with reference to FIGS. 4 and 5. Configuration 650 can also include flexible member construct 150A coupled around the two constructs 10 before fixed portion 34 of each construct 10 is coupled to the respective attachment member 80, as shown in FIG. 15. Construct 150A can be positioned generally in a superior-inferior orientation perpendicular to the transverse orientation of constructs 10. Construct 150A can be tensioned after tensioning constructs 10 to draw any remaining tension from the system. In this configuration, constructs 10 can provide cross-tensioning generally perpendicular to section 308 and construct 150A can provide tensioning generally parallel to section 308. Configuration 650 can also be utilized to compress the body 332 of sternum 304, where constructs 10 are wrapped around the sternum 304 instead of through holes 324, as also shown in FIG. 15.

Referring now to FIG. 16, another alternative configuration 670 for compression of sternum 304 in a sternal closure procedure is provided. Configuration 670 can include two separate continuous suture or flexible member loops 674 having a fixed length. Alternatively, a flexible member construct, such as construct 150, can be used in place of fixed loops 674 to provide additional adjustment and tensioning capability. Flexible member construct 150A can be provided with four attachment members 80 integrally coupled to loops 240, 240'. In the manubrium area, loops 674 can be routed or passed along the posterior side of sternum 304 in a transverse orientation such that opposed ends 678 of loops 674 extend through a respective pair of holes 324, as shown in FIG. 16. The opposed ends 678 of each of loops 674 can be coupled to a respective two of the four attachment members 80. The ends 158, 162 of flexible member construct 150A can then be tensioned to compress sternal portions 312, 316, as discussed herein. Additional configurations 670 can be used to compress body 332 of sternum 304 where the fixed loops are wrapped around the sides of sternum 304 as opposed to being passed through holes 324, as also shown in FIG. 16. It should be appreciated that configurations 650 and 670 can be used alone or with various combinations of the flexible member constructs and assembly configurations discussed herein.

Turning now to FIGS. 17-28, various frames or tensioning members are shown operatively associated with a flexible member or suture construct. The tensioning members can facilitate attachment and/or additional tensioning of the various suture constructs discussed above, as well as individual strands of suture, and can be used in addition to or in lieu of the various attachment members (e.g., 380, 430, 472) discussed above.

With particular reference to FIGS. 17-21, a tensioning member 700 is shown operatively associated with a pair of suture loops. The pair of suture loops can be loops of two separate strands of suture or can be the adjustable suture loops of the suture constructs 10, 150, 150A discussed above. In this regard, it should be appreciated that while the following discussion will continue with reference to adjustable loops 188, 188' of adjustable suture construct 150, the pair of adjustable loops shown operatively associated with tensioning member 700 can also include adjustable loops 66, 70 of suture construct 10, adjustable loops 240, 240' of suture construct 150A, loops of individual looped stands of suture, and/or a single strand of suture secured to each of the attachment members such as by wrapping and/or tying thereto. It should also be appreciated that while the tensioning members discussed herein illustrate adjustable suture loops of the suture constructs being attached thereto, other portions of the suture constructs discussed herein, such as the passage portions, can also be coupled to the attachment members in lieu of one of the adjustable loops.

The tensioning member 700 can be used to facilitate securing suture construct 150 around a fractured bone or the sectioned sternum 304 to compress the fracture or section and affect healing, as shown for example in FIGS. 29-31. The tensioning member 700 can be used for attachment of adjustable loops 188, 188' as well as to provide additional tensioning of suture construct 150 after the construct 150 has been tensioned as discussed above.

With particular reference to FIG. 17, tensioning member 700 can include a body 710 having a perimeter 714 with a generally circular shape 718. It should be appreciated that the shape of tensioning member 700 can be varied as may be desired for various surgical procedures and/or to facilitate gripping an outer perimeter of the tensioning member 700, as will be discussed below. Body 710 can include a first bone or soft tissue engaging side 722 and an opposite second or upper side 726. A pair of attachment members 730 and a first and second set of suture engaging members 734, 738 can extend from the upper side 726, as shown in FIG. 17. In the exemplary configuration shown in FIG. 17, the upper side 726 can include a substantially smooth or uninterrupted planar surface, except for members 730, 734 and 738, so as to not interfere with suture loops 188, 188' during adjustment of tensioning member 700, as will be discussed in greater detail below. Similarly, the first side 722 can also include a substantially smooth or uninterrupted planar bone engaging surface.

In the exemplary configuration shown in FIG. 17, the attachment members 730 can include a pair of opposed posts 744 having a first portion 748 extending from the upper side 726 and a second portion 752 having a larger diameter than the first portion 748 so as to form an undercut retention feature for retaining loops 188, 188'. Alternatively, the attachment members can include recessed posts 496, such as shown in FIG. 9, and/or recessed apertures, such as the attachment portions 384 of FIG. 7. In another exemplary alternative configuration, the suture or suture loops 188, 188' could be integrally formed with or attached to one of the attachment members 730.

The first and second set of suture engaging members 734, 738 can each include a plurality of ramped members 756 having an angled or inclined upper surface 758 with a first end 762 extending from the upper side 726 and a second end 766 spaced apart from the upper side **726** so as to form a wall **770** configured to selectively engage the suture loops **188**, **188'**. In an exemplary configuration, the wall **770** can be perpendicular or substantially perpendicular to upper side **726**. In another exemplary configuration, the wall **770** can include an arcuate portion and/or an undercut to aid in retention of the suture loops **188**, **188'**. In an exemplary configuration, the plurality of ramped members **756** can be positioned along an arcuate path, as shown for example in FIG. **17**.

The first and second set of suture engaging members **734**, **738** can include a varying number of ramped members **756** to provide a varying degree of tension adjustment capability, as will be discussed in greater detail below. In this regard, spacing **778** between the number of provide ramped members **756** can also be varied, such as the different spacing shown between the ramped members **756** of FIGS. **17** and **18**. Further, a distance **782** from the perimeter **714** to each of the attachment members **730** can be varied to vary an amount of additional tension applied to the suture construct **150** as the tensioning member **700** is rotated, as will also be discussed below in connection with operation of the tensioning member **700**.

With continuing reference to FIG. **17** and additional reference to FIGS. **18-20**, tensioning member **700** can include various features configured to facilitate rotationally driving tensioning member **700** to impart additional tension on suture construct **150**. For example, FIG. **17** illustrates a pair of apertures **794** extending through body **17** proximate a center thereof. Apertures **794** can receive a pair of projections **798** extending from a distal end **802** of a driver **806** (FIG. **26**). Rotation of driver **806** can thereby rotate tensioning member **700**, as will be discussed below. As another example, FIG. **18** illustrates a hexagon shaped aperture **810** in lieu of the pair of apertures **794**. For this configuration, driver **806** could include a singe projection (not shown) having a hexagon shaped outer surface sized and shaped to drivingly engaging the hexagon shaped aperture **810**.

FIG. **19** illustrates another exemplary configuration where a pair of notches **818** are formed in the perimeter **714** for receiving a corresponding driving tool (not shown) or to facilitate manual manipulation with a surgeon's or clinician's hand. In FIG. **20**, the perimeter **714** is shown with a hexagon shape **822** to facilitate hand manipulation by the surgeon or clinician. It should be appreciated that tensioning member **700** can be provided with one or more of the driving features discussed above. In this regard, it should also be appreciated that the attachment members **730** can be used in addition to or in lieu of the driving features discussed above to rotate tensioning member **700**.

With additional reference to FIGS. **21** and **29-31**, operation of tensioning member **700** will now be discussed in greater detail. Tensioning member **700** can be used to facilitate attachment of loops **188**, **188'** of suture construct **150**, as well as to provide additional tension to suture construct **150** after it has been tensioned in the manner discussed above in connection with the sternal closure procedure. In the exemplary procedure shown in FIGS. **29-31**, tensioning member **700** can be positioned on the sectioned sternum **304** (FIGS. **29-30**) and/or the fractured bone **840** (FIG. **31**) to facilitate attachment of suture construct **150** to the respective bone as well as providing additional tensioning capabilities.

As discussed above in connection with the sternal closure surgical procedure, suture construct **150** can be similarly wrapped around the sternum **304** or bone **840** such that the loops **188**, **188'** are coupled to the pair of attachment members **730**. Alternatively, passage portion **168** could be coupled to one of the attachment members **730** and the first and second loops **188**, **188'** could be coupled to the second attachment member. Similarly, in another alternative configuration, passage portion **168** of suture construct **150**A could be coupled to one of the attachment members and the first and second loops **240**, **240'** could be coupled to the other attachment member.

Free ends **158**, **162** of suture construct **150** can then be tensioned to reduce loops **188**, **188'** to the desired size and tension to compress and close section **308** of sternum **304** (or fracture **844** of bone **840**) and assist healing, as shown in FIGS. **29** and **31** with reference to FIG. **10** and attachment member **380**. With particular reference to FIG. **31**, suture construct **150** can be wrapped around bone **840** about fracture **844** to compress fractured bone portions **840**A and **840**B and promote healing. It should be appreciated that the tensioning members and suture constructs discussed herein can also be used in connection with two separate bones where the suture construct is wrapped around the two bones and tension is applied to draw the bones toward each other.

Once suture construct **150** has been tensioned as discussed above, tensioning member **700** can be optionally rotated to impart additional tension on suture construct **150** and thus additional compression on section **308** or fracture **844**. In the configuration illustrated in FIGS. **21** and **29-31**, tensioning member **700** can be rotated clockwise to impart additional tension on suture construct **150**. In particular, tensioning member **700** can be rotated clockwise to engage one of the ramped members **756** of each set of suture engaging members **734**, **738** with a respective adjustable loop **188**, **188'**, as shown in FIG. **21**. Rotation of tensioning member **700** in the clockwise direction will draw adjustable loop **188** in the direction of arrow A and will draw adjustable loop **188'** in the direction of arrow B thereby imparting additional tension on suture construct **150**, as also shown in FIG. **21**. As tensioning member **700** is rotated clockwise and attachment members **730** draw loops **188**, **188'** in the respective directions A and B, the ramped members **756** of the first and second set of suture engaging members **734**, **738** are brought into engagement with the respective adjustable loops **188**, **188'**.

As each ramped member **756** is brought into contact with the respecting suture loops **188**, **188'**, the inclined surface **758** is facing the adjustable loops **188**, **188'** and facilitates the adjustable loops **188**, **188'** sliding over the inclined surfaces **758** from the first end **762** toward the second end **766** to be positioned adjacent the wall **770** of a desired ramped member **756**. Upon a desired amount of tension being imparted on the suture construct **150** by rotation of tensioning member **700** such that the adjustable loops **188**, **188'** are positioned about the first and second set of suture engaging members **734**, **738**, an external force (e.g. surgeon's hand and/or driver **806**) that is being used to rotate tensioning member **700** can be removed. Upon removing the external driving force, the increased tension in suture construct **150** from rotation of tensioning member **700** can urge tensioning member **700** to rotate in a counterclockwise direction toward the initial position shown in FIGS. **17-20**. This action can bring the wall **770** of the ramped member **756** adjacent adjustable loops **188**, **188'** into contact with the adjustable loops **188**, **188'** such that the ramped members **756** exert a force on the adjustable loops **188**, **188'**, as shown in FIG. **21**.

As a result, the adjustable loops **188**, **188'** can be bent and tensioned around the respective engaging ramped members **756** such that a non-linearity **850** is created in the adjustable loops **188**, **188'**. This non-linearity **850** effectively increases a distance the adjustable loops **188**, **188'** are required to extend relative to the original position of the adjustable loops **188**, **188'** (before tensioning member **700** was rotated into engagement with adjustable loops **188**, **188'**) and thus increases the tension in suture construct **150**. In particular, the suture construct **150** can be tensioned about sectioned sternum **304** or fractured bone **840** to a first tension by tensioning the free ends **158**, **162** in the manner discussed above. In an exemplary aspect, the first tension can draw the respective bone portions into contact with each other and compress the bone portions together. Subsequently, the tensioning member **700** can be rotated in the manner discussed above to tension suture construct to a second tension and apply further compression to the bone portions to promote fusion and healing.

As can be appreciated, a larger degree of clockwise rotation of tensioning member **700** such that adjustable loops **188**, **188'** are engaged with ramped members **756** that are positioned further away (i.e., in a counterclockwise direction) from the adjustable loops **188**, **188'**, can impart a greater amount of additional tension on suture construct **150**. For example, rotating tensioning member **700** such that adjustable loops **188**, **188'** are positioned behind a second ramped member **756**B of the three ramped members **756** shown in FIG. **21** can create a larger bend or non-linearity **850** in adjustable loops **188**, **188'** as compared to the adjustable loops being positioned behind a first ramped member **756**A. Similarly, positioning the adjustable loops behind a third ramped member **756**C will create a larger non-linearity **850** than discussed above with respect to ramped members **756**B and thus provide the largest amount of additional tensioning associated with the exemplary tensioning member **700** shown in FIG. **21**. In this regard, it should be appreciated that additional ramped members **756** and/or increased spacing between the ramped members **756** can provide for additional tension increasing capability of tensioning member **700**.

With additional reference to FIGS. **22** and **23**, an alternative tensioning member **700**A will now be discussed. Tensioning member **700**A can be similar to tensioning member **700** such that like reference numerals refer to like features and only differences will be discussed in detail. Tensioning member **700**A can include an attachment member **870** configured to receive a flexible member **874**. Flexible member **874** can be a portion of one of the suture constructs **10**, **150**, **150**A discussed above, or can be a portion of an individual suture strand or a portion of a flexible member such as a wire. In an aspect where suture **874** is a portion of one of the suture constructs discussed above, it should be appreciated that a portion of one of the loops and/or the passage portions of such suture constructs can be received in attachment member **870**. Thus, while the following discussion will continue with reference to suture **874**, it will be appreciated that suture **874** is representative of any of the suture constructs discussed herein.

Attachment member **870** can include a protrusion **878** extending from the upper side **726**, as shown in FIG. **22**. The protrusion **878** can include a channel **882** extending therethrough that receives the suture **874**. In one exemplary aspect, attachment member **870** can include two separate protrusions **878** spaced apart from each other so as to form channel **882**. Tensioning member **700**A can similarly include a plurality of ramped members **756** positioned on the upper side **726** and extending along an arcuate path. In the exemplary configuration illustrated, the ramped members **756** can extend circumferentially around the body **710** proximate the perimeter **714**. In another exemplary configuration, the ramped members can be positioned as two sets, similar to the ramped members **756** of the first and second set of suture engaging members **734**, **738** of tensioning member **700**.

In operation, tensioning member **700**A can be rotated clockwise similar to the rotation discussed above for tensioning member **700** to impart additional tension on suture **874**. With particular reference to FIG. **23**, tensioning member **700**A can be rotated clockwise whereby channel **882** bends suture **874** and draws a portion of suture **874** proximate a first end **888** of channel **882** in the direction of arrow C and another portion of the suture **874** proximate a second end **892** of channel **882** in the opposite direction of arrow D. Such drawing of the suture **874** requires suture **874** to extend a greater distance and thus increases the tension in suture **874**.

Similar to tensioning member **700** discussed above, the rotation of tensioning member **700**A can cause suture **874** to slide over ramped members **756** until a rotational driving force used to rotate tensioning member **700**A is removed. In this regard, it should be appreciated that tensioning member **700**A can include one or more of the driving features discussed above in connection with tensioning member **700**. For example, apertures **794** can be positioned in each of protrusions **78** and/or the outer perimeter can include the notches **818** or hexagon shape **822**. Upon removal of the driving force, the additional tension in suture **874** can urge tensioning member **700**A to rotate in the counterclockwise direction partially back toward the original position shown in FIG. **23**. However, as with tensioning member **700**, the ramped member wall **770** adjacent the suture **874** can engage the suture **874** and resist such counter rotation in cooperation with channel **882** and thereby create the non-linearity or bend **850** in suture **874**. The non-linearity **850** requires the suture **874** to extend a greater distance and thereby increases the tension in suture **874** similar to tensioning member **700**. Further, tensioning member **700**A can automatically maintain the increased tension in suture **874** similar to tensioning member **700** due to the counteracting forces imparted on suture **874** from the engaging ramped members **756** and the attachment members **870**.

With additional reference to FIGS. **24-26**, a tensioning member **910** is shown in accordance with the present teachings. Tensioning member **910** can include a body **914** having an upper surface **918** and an opposite lower tissue or bone engaging surface **920**. Body **914** can define a generally rectangular perimeter **922**, although it should be appreciated that tensioning member **910** can include a body **914** with other shapes as may be desired depending on different procedures in which tensioning member **910** may be used. A pair of generally centrally located attachment members **926** can extend from the upper surface **918** and can include an undercut portion **930** similar to that discussed above for attachment members **730**. Attachment members **926** can each include an aperture **934** formed in a top surface thereof configured to receive the projections **798** of driver **806**, as will be discussed below.

In the exemplary configuration illustrated in FIG. **24**, the pair of attachment members **926** can be spaced apart from each other such that they are offset from each other in both a longitudinal direction of body **914** and a perpendicular lateral direction of body **914**. The offset can facilitate generating the bending of suture **874** similar to the tensioning members discussed above. As also discussed above, tensioning member **910** can be used in addition to or in lieu of the various attachment members **380**, **430** and **472** shown for example in FIGS. **7-9**. Further, tensioning member **910** can also be used with any of the suture constructs discussed herein similar to that discussed above for tensioning members **700** and **700**A.

Tensioning member **910** can include a single ramped member **756** extending from the upper surface **918** and spaced apart from each of the respective attachment members **926** in a direction toward opposed longitudinal ends **938**, as shown in FIG. **24**. It should be appreciated that tensioning member **910** can alternatively include a plurality of ramped members **756**, such as shown for example in FIG. **27**. It should also be appreciated that tensioning member **910** can use any of the alternative driving features discussed above in lieu of or in addition to the apertures **934**.

In operation, tensioning member **910** can be positioned on soft tissue or bone and suture **874** or one of the suture constructs discussed herein can be positioned between attachment members **926**, as shown in FIGS. **24** and **25**. The suture **874** can then be tensioned around the sternum **304** or other bone **840** to compress the respective section **308** or fracture **844** as discussed above and shown in FIG. **31**. Tensioning member **910** can then be rotated clockwise using driver **806** or another suitable method and/or instrument. For example, the projections **798** of driver **806** can be positioned in apertures **934**. Driver **806** can then be rotated to rotate tensioning member **910** clockwise and drive attachment members **926** into portions of suture **874** and draw the suture **874** in the direction of arrows E and F shown in FIG. **25**. Drawing suture **874** in the direction of arrows E and F requires the suture **874** to extend over a greater distance thereby increasing the tension in suture **874**.

Tensioning member **910** can be rotated clockwise until suture **874** slides over ramped members **756**. The rotational driving force (i.e., from driver **806**) can then be removed, upon which tensioning member **910** can be urged counterclockwise partially toward the initial position shown in FIG. **24** until the walls **770** of ramped members **756** engage suture **874**. This action can impart a force on suture **874** thereby causing the non-linearity or bending **850** relative to each attachment member **926** and ramped member **756**. In this regard, a first one of the attachment members **926**A can engage a first side **940** of suture **874** and the wall **770** of the adjacent ramped member **756** can engage a second opposite side **942** of suture **874**. Similarly, a second one of the attachment members **926**B can engage the second side **942** of suture **874** and the wall **770** of the corresponding ramped member **756** can engage the first side **940**, as shown in FIG. **25**.

The non-linearity **850** can effectively increase a distance the suture **874** is required to extend, such as around bone **840** to compress fracture **844**, and can thereby increase tension in suture **874**, as shown for example in FIG. **31**. In the exemplary configuration shown in FIG. **25**, the non-linearity **850** with respect to attachment member **926**A can include a first bend or non-linearity **850**A as the suture is bent around attachment member **926**A, and a second non-linearity **850**B as the suture is bent around the associated ramped member **756**. Similarly, the non-linearity with respect to attachment member **926**B can include a third bend or non-linearity **850**C as the suture is bent around attachment member **926**B, and a fourth non-linearity **850**D as the suture is bent around the associated ramped member **756**. The tension in suture **874** in cooperation with the engagement of the ramped members **756** and the attachment members **926** can automatically maintain the non-linearity **850** and increased tension in suture **874** imparted by tensioning member **910**.

With additional reference to FIGS. **27** and **28**, a tensioning member **910**A is shown according to the present teachings. Tensioning member **910**A can be similar to tensioning member **910** such that like reference numerals refer to like components and only differences will be discussed in detail. Tensioning member **910**A can include two sets of ramped members **756** spaced apart from the respective attachment members **926**, as shown in FIG. **27**. In an exemplary aspect, each set of ramped members **756** can be positioned in an arcuate path. In an exemplary aspect, each set of ramped members **756** can be positioned relative to a longitudinal centerline **950** such that a first set **954** of the ramped members **756** are positioned between centerline **950** and a first lateral side **958** and a second set **962** of the ramped members **756** are positioned between centerline **950** and a second opposite lateral side **966**. Tensioning member **910**A can also include the hexagon shaped aperture **810** in place of or in addition to the apertures **934**.

In operation, tensioning member **910**A can be utilized in a similar manner as tensioning member **910** and can be used in addition to or in lieu of tensioning members **700**, **700**A and **910**. Further, tensioning member **910**A can be used in lieu of or in addition to attachment members **380**, **430**, and/or **472**. For example, and with reference to FIGS. **29** and **30**, tensioning member **910**A can be positioned on the sternum **304** and suture **874** (or one of the suture constructs discussed above) can be positioned around the sternum **304** and section **308**. The suture **874** or suture construct **150** can then be appropriately tensioned. Tensioning member **910**A can then be rotated in a clockwise direction to engage attachment members **926** and ramped members **756** with suture **874** in the manner discussed above and shown in FIG. **31** to impart additional tension on suture **874**.

Turning now to FIGS. **32-33**, a tensioning member **1000** is shown in accordance with the present teachings. Tensioning member **1000** can include a body **1004** having a first or upper surface **1008** and a second or bone engaging surface **1012**. Tensioning member **1000** can define an outer perimeter **1016** and, in the exemplary configuration illustrated, can have an elongated or rectangular shape. Tensioning member **1000** can include a first set of fastener receiving holes **1020** extending through body **1004**, as shown in FIG. **32**. It should be appreciated that tensioning member **1000** can include more or less than the set of two fastener receiving holes **1020** illustrated in FIGS. **32** and **33**. Tensioning member **1000** can also include a pair of attachment members **1024** that can be similar to attachment members **730** discussed above. Attachment members **1024** and can be positioned along an axis perpendicular to a longitudinal axis **1028** of tensioning member **1000**, as shown in FIG. **32**, or at an offset angle from perpendicular, as shown in FIG. **33**. Attachment members **1024** can be configured to receive suture **874** or loops of one or more of the suture constructs discussed above, such as loops **188**, **188'** of construct **150**. Tensioning member **100** can further include a pair of apertures **1032** configured to receive projection **798** of driver **806** similar to apertures **934** discussed above.

In operation, tensioning member **1000** can be positioned relative to the fractured bone **840** or sectioned sternum **304**. Tensioning member **1000** can be coupled to one of the suture constructs, such as to the loops **188**, **188'** of exemplary suture construct **150**, in a manner similar to tensioning member **700** discussed above in connection with FIGS. **30** and **31**. Driver **806** can then be used to rotate tensioning member **1000** to impart additional tension on to associated suture construct **150** by requiring suture construct **150** to span or extend a longer distance similar to operation of the tensioning members discussed above. Upon rotating tensioning member **1000** to impart a sufficient amount of additional tension onto associated suture construct **150** and/or compression onto section **308** or fracture **844**, a pair of bone screws or fasteners **1038** can secure tensioning member **1000** in the tensioned and rotated position to the sternum **304** or bone **840**.

With additional reference to FIGS. **34-36**, another tensioning member **1000'** is shown in accordance with the present teachings. Tensioning member **1000'** can be similar to tensioning member **1000** such that like reference numerals refer to like components and features and only differences will be discussed in detail. Tensioning member **1000'** can include a pair of attachment members **1050** in the form of apertures in place of attachment members **1024** of tensioning member

1000. Attachment members **1050** can be positioned along an axis substantially perpendicular to longitudinal axis of **1028** or offset therefrom, as shown in the exemplary configuration of FIG. **34**.

In operation, flexible anchors **196** associated with any of the suture constructs discussed above, such as construct **150**A of FIG. 3B or construct **10**A of FIG. **35**, can be coupled to attachment members **1050**. In particular, one of the flexible anchors **196** carried by a respective suture construct can be coupled to one of the attachment members **1050**. Tensioning member **1000'** can then be positioned about fracture **844** or section **308** and wrapped around the respective bone **840** or sternum **308**. The other flexible anchor **196** coupled to an opposite end of the respective suture construct, such as construct **10**A, can be coupled to the other attachment member **1050**, as generally shown in FIG. **36**. Tensioning member **1000'** can then be tensioned and secured in a similar manner as tensioning member **1000** discussed above.

Turning now to FIGS. **37-40**, a tensioning member **1070** is shown in accordance with the present teachings. Tensioning member **1070** can operate similarly to tensioning member **1000** and can include a body **1074** in the form of an I-shape **1078** in the exemplary configuration illustrated. In this exemplary configuration, body **1074** can include a first portion **1082** having opposed ends **1086** and **1090**. First portion **1082** can define a longitudinal axis **1094** of tensioning member **1070**. Second and third portions **1098** and **1102** can extend perpendicular or substantially perpendicular to first portion **1082** about respective ends **1086** and **1090** thereby forming the I-shape **1078**.

Similar to tensioning member **1000**, first portion **1082** can include a pair of attachment members **1106** and a pair of driver engagement apertures **1110**. Attachment members **1106** can be positioned along an axis substantially perpendicular to longitudinal axis **1094**, or along an axis offset from perpendicular to longitudinal axis **1094**, as shown in FIG. **37**. Each of the second and third portions **1098** and **1102** can include at least one bone screw receiving aperture **1114**. In the exemplar configuration illustrated, each of the second and third portions **1098** and **1102** include four apertures **1114** configured to receive bone screws **1038**.

In operation, tensioning member **1070** can be positioned relative to fractured bone **840** or sectioned sternum **304**, as shown in FIG. **37**. One of the suture constructs discussed above can be coupled to attachment members **1106**, such as via loops **188**, **188'** of exemplary suture construct **150**. Suture construct **150** can then be tensioned in the manner discussed above to impart compression on fracture **844** or section **308**. Tensioning member **1070** can then be rotated to impart additional tension onto suture construct **150** and compression onto fracture **844** or section **308**, as generally shown in FIGS. **37** and **38**. In this regard, by having the attachment members **1106** offset from perpendicular to the longitudinal axis, as shown in FIG. **37**, rotation of tensioning member **1070** can bring longitudinal axis **1094** generally in line with fracture **844** or section **308** such that the second and third portions **1098**, **1102** span fracture **844** or section **308**, as generally shown in FIG. **38**.

Bone screws **1038** can then received through apertures **1114** to secure tensioning member **1070** to bone **840** or sternum **304** in the rotated position, as shown in FIG. **39**. In this regard, tensioning member **1070** can be used not only to impart additional tension on the associated suture construct, but also to secure the fracture bone **840** or section sternum **304** together in its compressed state when second and third portions **1098**, **1102** span both sides of fracture **844** or section **308**, as also shown in FIG. **39**.

With additional reference to FIG. **40**, an alternative exemplary process for rotating tensioning member about bone **840** or sternum **304** will be discussed. Tensioning member **1070** can be positioned relative to the fractured bone **840** or sternum **304** in a similar manner as discussed above such that the longitudinal axis **1094** of tensioning member **1070** is angled relative to fracture **844** or section **308** and tensioning member **1070** is skewed to one side of fracture **844** or section **308**, as shown in FIG. **40**. One bone screw **1038** can be positioned in the second portion **1098** and partially secured to bone **840** or sternum **304** so as to initially serve as a pivot point **1122** for rotating tensioning member **1070**. In the exemplary configuration illustrated in FIG. **40**, bone screw **1038** can be positioned in one of the apertures **1114** that is furthest from fracture **844** or section **308**. Suture construct **150** can then be coupled to attachment members **1106** in the manner discussed above.

Tensioning member **1070** can then be rotated about the partially secured bone screw **1038** in a direction toward fracture **844** or section **308** so as impart additional tension onto suture construct **150** and thus compression onto fracture **844** or section **308**. Once tensioning member **1070** is rotated to the position generally shown in FIG. **39**, the additional bone screws **1038** can be positioned in the apertures **1114** and all of the bone screws **1038** can be driven into the associated bone to secure tensioning member **1070** thereto in the rotated state.

Turning now to FIG. **41**, a tensioning member assembly **1130** is shown in accordance with the present teachings. Tensioning member assembly **1130** can include a first member **1132** having a body **1134** and a second member **1136** configured to be selectively movable relative thereto, as will be discussed below in greater detail. Body **1134** can include a pair of bone screw receiving holes **1138** proximate opposed ends **1142** thereof. In the exemplary configuration illustrated, body **1134** can be elongated so as to have an oval or rectangular shape. Body **1134** can also include a centrally positioned circular closed-end recess or pocket **1146** having an opening **1150** formed in an upper surface **1152** of body **1134** opposite a bottom or bone engaging surface **1154**.

Pocket **1146** can extend partially toward bone engaging surface **1154** and can include a floor or bottom **1158** and a perimeter sidewall **1162**. Alternatively, pocket **1146** can be formed as an aperture extending through body **1134**. The sidewall **1162** of pocket **1146** can include a splined configuration **1164** configured to mate or mesh with a complimentary splined configuration **1166** of second member **1136**. In the exemplary configuration illustrated, the sidewall **1162** can include the splined configuration **1164** on only a lower portion **1168** proximate bone engaging surface **1154** such that an upper portion **1172** does not include splined configuration **1164**.

Second member **1136** can include an upper surface **1178**, a lower surface **1182** and an outer perimeter **1186**. In the exemplary configuration illustrated in FIG. **41**, second member **1136** can have a circular shape with a diameter complimentary to a diameter of pocket **1146**. The outer perimeter **1186** can include the splined configuration **1166** such that second member **1136** can be selectively received in splined engagement with first member **1132**. A pair of attachment members **1190** can extend from the upper surface **1178** in a similar manner as the various attachment members discussed above. A pair of driver engagement apertures **1194** can also be formed in the upper surface **1178** for receiving driver **806**.

In operation, one of the suture constructs discussed above, such as construct **150**, can be coupled to attachment members **1190** of second member **1136**. First member **1132** can be positioned about a fractured bone, such as bone **840**, and secured thereto with bone screws **1038**. Second member **1136** can be coupled to driver **806** and positioned proximate first member **1132**. In one exemplary configuration, the driver **806** can be configured to cooperate with the second member **1136** such that second member **1136** can remain removably coupled to driver **806** upon engagement of projections **798** with apertures **1194**. In one exemplary configuration, second member **1136** can be positioned relative to pocket **1146** such that the splined configuration **1166** resides in the upper portion **1172** of sidewall **1162** and does not engage the splined configuration **1164** of pocket **1146**. Second member **1136** can be rotated via driver **816** to impart additional tension onto tensioned suture construct **150** optionally using upper portion **1172** as a guide. Upon imparting the desired additional tension onto suture construct **150** and thus compression onto fractured bone **840**, second member **1136** can be positioned in pocket **1146** such that the second member splined configuration **1166** engages the first member splined configuration **1164** thereby preventing relative movement between the first and second members **1132**, **1136** to maintain the additional tension and compression.

With additional reference to FIG. **42**, another tensioning member assembly **1200** is shown in accordance with the present teachings. Aspects of tensioning member assembly **1200** can be similar to tensioning member assembly **1130** such that like reference numerals refer to like features and only differences will be discussed in detail. Tensioning member assembly **1200** can similarly include a first member **1204** and a second member **1208**. Second member **1208** can be configured to be received in a pocket **1212** formed in the body **1134** of first member **1204**. Pocket **1212** can be similar to pocket **1146**, but can include a plurality of ramped members **1218** on floor **1158** in place of the splined configuration **1164**. As will be discussed in greater detail below, ramped members **1218** can be configured to cooperate with a corresponding plurality of opposed ramped members **1222** on second member **1208** to allow selective rotation of second member **1208** relative to first member **1204** in a first predetermined rotation direction while preventing relative rotation in a second opposite rotational direction.

Similar to tensioning member assembly **1130**, second member **1208** can have a diameter complimentary to a diameter of pocket **1212**. Second member **1208** can also include the plurality of ramped members **1222** on bottom or lower surface **1182** radially spaced so as to align with the plurality of ramped members **1218** of first member **1204**. In this regard, as can be seen in FIG. **42**, the ramped members **1218**, **1222** can cooperate to allow rotation of the second member **1208** relative to the first member **1204** in the first rotational direction where inclined surfaces **1228**, **1232** of respective ramped members **1218**, **1222** can slide relative to each other, and can prevent rotation in the second rotational direction where end faces **1236**, **1240** of respective ramped members **1218**, **1222** can engage each other.

In operation, loops **188**, **188'** of suture construct **150** can be coupled to second member **1208** in a similar manner as second member **1136** discussed above. Likewise, first member **1204** can be positioned about fractured bone **844** and coupled thereto with bone screws **1038**. Second member **1208** can be positioned in pocket **1212** such that the ramped members **1218**, **1222** are in engagement or substantial engagement with each other. Suture construct **150** can be tensioned in the manner discussed above to compress fractured bone portions **840**A, **840**B (or sectioned sternum **304**) together also in a similar manner as discussed above. Driver **806** can be coupled to second member **1208**, if not already coupled thereto, and can be used to rotate second member **1208** in the first direction relative to first member **1204** to impart additional tension on suture construct **150** and thus compression on fracture **844** of bone **840**. Upon imparting the desired additional tension and compression, driver **806** can be released thereby allowing the second member **1208** to rotate slightly in the second direction until the end faces **1236**, **1240** engage each other thereby preventing any further rotation in the second direction and maintaining the additional imparted tension on suture construct **150** and thus compression on fractured bone **840**.

While one or more specific examples have been described and illustrated, it will be understood by those skilled in the art that various changes may be made and equivalence may be substituted for elements thereof without departing from the scope of the present teachings as defined in the claims. Furthermore, the mixing and matching of features, elements and/or functions between various examples may be expressly contemplated herein so that one skilled in the art would appreciate from the present teachings that features, elements and/or functions of one example may be incorporated into another example as appropriate, unless described otherwise above. Moreover, many modifications may be made to adapt a particular situation or material to the present teachings without departing from the essential scope thereof.

What is claimed is:

1. A method for applying tension to a flexible member, comprising:

positioning a tensioning member relative to a first bone portion and a second bone portion, the tensioning member having first and second flexible member attachment members and a corresponding set of first and second flexible member engaging members extending therefrom;

positioning the flexible member about the first and second bone portions;

coupling the flexible member to the first and second attachment members;

tensioning the flexible member to draw the first and second bone portions toward each other under a first tension;

rotating the tensioning member such that the first and second attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension;

engaging the flexible member with the first and second flexible member engaging members and creating a nonlinearity in the flexible member about each of the flexible member engaging members; and

maintaining the second tension via engagement of the flexible member with the first and second attachment members and the first and second engagement members in an absence of an external force.

2. The method of claim **1**, wherein positioning the flexible member about the first and second bone portions includes wrapping the flexible member around the first and second bone portions.

3. The method of claim **1**, wherein coupling the flexible member to the first and second attachment members includes coupling a first adjustable loop of an adjustable suture construct formed from a suture to a first post and coupling a second adjustable loop of the adjustable suture construct to a second post, the first and second adjustable loops extending from a passage portion of the adjustable suture construct.

4. The method of claim **1**, wherein coupling the flexible member to the first and second attachment members includes coupling an adjustable suture construct formed from a suture to the first and second attachment members, the adjustable suture construct having a first end of the suture that extends through a first aperture defined by the suture into the passage portion and out a second aperture defined by the suture so that the first end is outside of the passage portion and defines a first adjustable loop, and having a second end of the suture that extends through the second aperture into the passage portion and out the first aperture so that the second end is outside of the passage portion and defines a second adjustable loop.

5. The method of claim **4**, wherein coupling the flexible member to the first and second attachment members includes coupling the first adjustable loop to the first attachment member and coupling the second adjustable loop to the second attachment member.

6. The method of claim **4**, wherein coupling the flexible member to the first and second attachment members includes coupling the first and second adjustable loops to the first attachment member and coupling the passage portion to the second attachment member.

7. The method of claim **1**, wherein tensioning the flexible member to draw the first and second bone portions toward each other under a first tension includes tensioning the flexible member relative to the first and second attachment members.

8. The method of claim **1**, wherein rotating the tensioning member such that the attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension includes engaging a driver with the tensioning member and rotating the driver to rotate the tensioning member.

9. The method of claim **1**, wherein engaging the flexible member with the first and second flexible member engaging members includes:

sliding the flexible member over a first ramped surface of the flexible member engaging members; and

engaging the flexible member against a second side surface of the flexible member engaging member;

wherein the flexible member is bent around the second side surface of each flexible member engaging member thereby creating the non-linearity.

10. The method of claim **9**, wherein the first and second flexible member engaging members include a first and second plurality of flexible member engaging members each having the first ramped surface and second side surface, each plurality of flexible member engaging members being positioned consecutively in a single row;

wherein continued rotation of the tensioning member slides the flexible member over consecutive flexible member engaging members of each of the first and second plurality of flexible member engaging members; and

wherein engaging the flexible member with each consecutive ramped member second side surface increases the second tension applied to the flexible member and first and second bone portions.

11. The method of claim **1**, wherein tensioning the flexible member to draw the first and second bone portions toward each other under a first tension includes compressing the first and second bone portions of the same fractured bone.

12. The method of claim **1**, wherein tensioning the flexible member to draw the first and second bone portions toward each other under a first tension includes drawing the first and second bone portions of a different bone toward each other.

13. The method of claim **1**, wherein engaging the flexible member with the first and second flexible member engaging members and creating a non-linearity in the flexible member about each of the flexible member engaging members includes engaging a first side of the flexible member with the first engaging member and engaging a second side of the flexible member opposite the first side with the second engaging member.

14. The method of claim **1**, wherein engaging the flexible member with the first and second flexible member engaging members and creating a non-linearity in the flexible member about each of the flexible member engaging members includes:

engaging a first side of the flexible member with the first attachment member and a second opposite side of the flexible member with the first engaging member; and

engaging the second side of the flexible member with the second attachment member and the first side of the flexible member with the second engaging member.

15. A method for applying tension to a suture, comprising:

positioning a tensioning member relative to a first bone portion and a second bone portion, the tensioning member having first and second suture attachment members and a corresponding first and second plurality of suture engaging members extending therefrom;

positioning an adjustable suture construct about the first and second bone portions;

coupling first and second adjustable loops of the adjustable suture construct to the first and second attachment members;

tensioning free ends of the adjustable suture construct to reduce a size of the first and second adjustable loops and draw the first and second bone portions toward each other under a first tension;

rotating the tensioning member such that the first and second attachment members draw the adjustable suture construct in opposite directions applying additional tension to the suture construct to place the suture construct and the first and second bone portions under a second tension;

engaging the first and second adjustable loops with a respective one of the plurality of first and second suture engaging members and creating a non-linearity in the adjustable loops about each of the one of the plurality of first and second suture engaging members; and

maintaining the second tension via engagement of the first and second adjustable loops with the first and second suture attachment members and the one of the plurality of first and second suture engagement members in an absence of an external force.

16. The method of claim **15**, wherein engaging the first and second adjustable loops with the respective one of the plurality of first and second suture engaging members and creating the non-linearity in the adjustable loops about each of the one of the plurality of first and second suture engaging members includes:

sliding the first and second adjustable loops over a ramped surface of the respective one of the plurality of first and second engaging members; and

engaging the first and second adjustable loops against a side surface of the respective one of the plurality of first and second engaging members;

wherein the first and second adjustable loops are bent around the side surfaces thereby creating the non-linearity.

17. The method of claim **16**, wherein the first and second plurality of suture engaging members are each positioned consecutively in a single row, each consecutively positioned suture engaging member after a first suture engaging member of the first and second plurality of suture engaging members providing additional tension to the adjustable suture construct upon engagement with the respective first and second adjustable loops; and

wherein sliding the first and second adjustable loops over the ramped surface of the respective one of the plurality of first and second engaging members includes rotating the tensioning member to slide the first and second adjustable loops over the ramped surfaces of a respective sub-plurality of the plurality of first and second suture engaging members.

18. The method of claim **15**, wherein tensioning free ends of the adjustable suture construct to reduce a size of the first and second adjustable loops and draw the first and second bone portions toward each other under a first tension includes compressing the first and second bone portions of the same fractured bone.

19. The method of claim **18**, wherein tensioning free ends of the adjustable suture construct to reduce a size of the first and second adjustable loops includes compressing the first and second bone portions of a sectioned sternum.

20. The method of claim **15**, wherein tensioning free ends of the adjustable suture construct to reduce a size of the first and second adjustable loops and draw the first and second bone portions toward each other under a first tension includes drawing the first and second bone portions of a different bone toward each other.

21. A method for applying tension to a flexible member, comprising:

positioning a tensioning member relative to a first bone portion and a second bone portion, the tensioning member having first and second flexible member attachment members and a corresponding set of first and second flexible member engaging members extending therefrom;

positioning the flexible member about the first and second bone portions;

coupling the flexible member to the first and second attachment members;

tensioning the flexible member to draw the first and second bone portions toward each other under a first tension;

rotating the tensioning member such that the first and second attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension;

engaging the flexible member with the first and second flexible member engaging members and creating a non-linearity in the flexible member about each of the flexible member engaging members; and

maintaining the second tension via engagement of the flexible member with the first and second attachment members and the first and second engagement members in an absence of an external force;

wherein rotating the tensioning member such that the attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension includes engaging a driver with the tensioning member and rotating the driver to rotate the tensioning member.

22. The method of claim **21**, wherein positioning the flexible member about the first and second bone portions includes wrapping the flexible member around the first and second bone portions.

23. The method of claim **21**, wherein coupling the flexible member to the first and second attachment members includes coupling a first adjustable loop of an adjustable suture construct formed from a suture to a first post and coupling a second adjustable loop of the adjustable suture construct to a second post, the first and second adjustable loops extending from a passage portion of the adjustable suture construct.

24. The method of claim **21**, wherein coupling the flexible member to the first and second attachment members includes coupling an adjustable suture construct formed from a suture to the first and second attachment members, the adjustable suture construct having a first end of the suture that extends through a first aperture defined by the suture into the passage portion and out a second aperture defined by the suture so that the first end is outside of the passage portion and defines a first adjustable loop, and having a second end of the suture that extends through the second aperture into the passage portion and out the first aperture so that the second end is outside of the passage portion and defines a second adjustable loop.

25. The method of claim **21**, wherein engaging the flexible member with the first and second flexible member engaging members includes:

sliding the flexible member over a first ramped surface of the flexible member engaging members; and

engaging the flexible member against a second side surface of the flexible member engaging member;

wherein the flexible member is bent around the second side surface of each flexible member engaging member thereby creating the non-linearity.

26. The method of claim **25**, wherein the first and second flexible member engaging members include a first and second plurality of flexible member engaging members each having the first ramped surface and second side surface, each plurality of flexible member engaging members being positioned consecutively in a single row;

wherein continued rotation of the tensioning member slides the flexible member over consecutive flexible member engaging members of each of the first and second plurality of flexible member engaging members; and

wherein engaging the flexible member with each consecutive ramped member second side surface increases the second tension applied to the flexible member and first and second bone portions.

27. A method for applying tension to a flexible member, comprising:

positioning a tensioning member relative to a first bone portion and a second bone portion, the tensioning member having first and second flexible member attachment members and a corresponding set of first and second flexible member engaging members extending therefrom;

positioning the flexible member about the first and second bone portions;

coupling the flexible member to the first and second attachment members;

tensioning the flexible member to draw the first and second bone portions toward each other under a first tension;

rotating the tensioning member such that the first and second attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension;

engaging the flexible member with the first and second flexible member engaging members and creating a non-linearity in the flexible member about each of the flexible member engaging members; and

maintaining the second tension via engagement of the flexible member with the first and second attachment members and the first and second engagement members in an absence of an external force;

wherein engaging the flexible member with the first and second flexible member engaging members includes:

sliding the flexible member over a first ramped surface of the flexible member engaging members; and

engaging the flexible member against a second side surface of the flexible member engaging member;

wherein the flexible member is bent around the second side surface of each flexible member engaging member thereby creating the non-linearity; and

wherein the first and second flexible member engaging members include a first and second plurality of flexible member engaging members each having the first ramped surface and second side surface, each plurality of flexible member engaging members being positioned consecutively in a single row;

wherein continued rotation of the tensioning member slides the flexible member over consecutive flexible member engaging members of each of the first and second plurality of flexible member engaging members; and

wherein engaging the flexible member with each consecutive ramped member second side surface increases the second tension applied to the flexible member and first and second bone portions.

28. The method of claim **27**, wherein positioning the flexible member about the first and second bone portions includes wrapping the flexible member around the first and second bone portions.

29. The method of claim **27**, wherein coupling the flexible member to the first and second attachment members includes coupling a first adjustable loop of an adjustable suture construct formed from a suture to a first post and coupling a second adjustable loop of the adjustable suture construct to a second post, the first and second adjustable loops extending from a passage portion of the adjustable suture construct.

30. The method of claim **27**, wherein coupling the flexible member to the first and second attachment members includes coupling an adjustable suture construct formed from a suture to the first and second attachment members, the adjustable suture construct having a first end of the suture that extends through a first aperture defined by the suture into the passage portion and out a second aperture defined by the suture so that the first end is outside of the passage portion and defines a first adjustable loop, and having a second end of the suture that extends through the second aperture into the passage portion and out the first aperture so that the second end is outside of the passage portion and defines a second adjustable loop.

31. The method of claim **27**, wherein rotating the tensioning member such that the attachment members draw the flexible member in opposite directions applying additional tension to the flexible member to place the flexible member and the first and second bone portions under a second tension includes engaging a driver with the tensioning member and rotating the driver to rotate the tensioning member.

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